United States
Department of
Agriculture

Forest Service

Forest Health
Protection

Davis, CA

SIXTH REPORT

NATIONAL STEERING COMMITTEE FOR MANAGEMENT OF SEED, CONE, AND REGENERATION INSECTS

FPM 95-11
April 1995

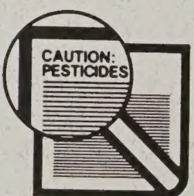
Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.



FPM 95-11
April, 1995

Sixth Report

National Steering Committee for Management of Seed, Cone, and Regeneration Insects

Prepared by:

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Chairperson

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CONTENTS

I. INTRODUCTION

A. Place and Purpose of Meeting

The 1994 meeting of the National Steering Committee for Management of Seed, Cone, and Regeneration Insects met at Rhinelander, WI, June 28-30, 1994. The meeting was hosted by Steve Katovich, St. Paul Field Office, St. Paul, MN, to whom the committee expresses its appreciation for his and those of his cooperators in providing an informative field trip and hospitality. The meeting call letter and agenda are in Appendix A. The committee spent two days in meetings and one day visiting regeneration facilities and wild stands. The purpose of the meeting was to identify FPM Technology Development needs and to discuss update of the tactical plan.

B. Attendees

Larry Barber	R-8/FPM (Asheville, NC)
Gary DeBarr	SE Station (Athens, GA)
Jed Dewey	R-1/FPM (Missoula, MT)
Steven Katovich	NA/FPM (St. Paul, MN)
Sandy Kegley	R-1/FPM (Coeur d'Alene, ID)
Chuck Masters	Weyerhaeuser Co. (Centralia, WA)
Dick Meier	FS (Rhinelander, WI)
Nancy Rappaport	PSW/FIDR (Albany, CA)
Dave Rising	MTDC (Missoula, MT)
Darrell Ross	OSU (Corvallis, OR)
Walter Ruckheim	Lakewood Ranger District (Lakewood, WI)
Roger Sandquist	R-6/FPM (Portland, OR)
Tim Schowalter	OSU (Corvallis, OR)
Bill Sery	Oconto River Seed Orchard (White Lake, WI)
John Taylor	R-8/Forest Health (Atlanta, GA)
Jack Barry, Chairperson	WO/FPM (Davis, CA)

C. Committee Member Reports

Please see reports included in Appendix B.

II. DISCUSSIONS

A. National Needs and Priorities

These are listed in Appendix C.

B. Special Needs

1. Technology Development Program and its relationship to other FPM programs

   - It was agreed at the National FPM Director's meeting to conduct a national review in 1995. Post script - Ann Bartuska, Director, Forest Health Protection, decided against a review as announced at FPM Directors Meeting at Orlando, FL, March 28, 1995.

2. Scheduling of this committee's national meetings

   - It was agreed at the Rhinelander meeting to hold future meetings in July and after July 4th.

3. Representative of State Foresters on this committee

   - The committee agreed that it would be desirable to have someone on the committee to represent needs of the States. The chair invites nominations for the committee.

4. Cooperation

   - Members stressed the need to foster cooperation among all levels and organizations, both public and private, in seed, cone, and regeneration insect management.

5. Non-Forest Service funding for seed, cone, and regeneration insect activities

   - This was not discussed in any detail but options and opportunities should be explored via grants, cooperative projects, and sharing of resources - all private and public sources included.

6. Scope of charter

- The committee reaffirms, by unanimous vote, to retain management of regeneration insects in its charter.

7. Strategic Plan

- The committee decided to pursue development of a strategic/tactical plan, that, when completed would replace the current tactical plan. The latter will be maintained and updated until it is replaced.

C. Open Reporting and Discussion

Comments recorded from floor discussions as listed below.

Larry Barber (R-8)

- Working in hardwoods, mainly and white pine beetle problems. Also working with northern red oak, 30' tall trees, in Tenn.

- See emphasis need for long leaf pine and sand pine in Florida and Northern red oak in South.

Gary DeBarr (SE)

- Duty to get seed to private sector to take up gap of timber lost from National Forest lands.

- A lot of progress on pheromones.

- Ohio white pine orchard, tried trap-out strategy with 40 traps on 4 acres, 2400 plus beetles caught in 1993. Beetles there responded to pheromone for a long time.

- Need to do pheromone trap out/disruption on a regional basis.

- Pherotech interested in the pheromones - cannot demonstrate reduced loss from mating disruption -- may only work in isolated orchards.

Jed Dewey (R-1)

- R-1 regional genetics folks canvassed by Jed.
- Western WP, larch, ponderosa pine and Douglas-fir seed will be needed.
- White bark pine big interest - need an insect resistance program for white bark.
- EM is causing a redirection - more towards site restoration. Seed, especially rust resistant western white pine, will be needed for this.
- Reduction overall of seed production and shift in species type needed.
- Drop lodgepole pine - let natural regeneration take care.
- Expected areas will be needed for intensive fiber production.
- Nursery production is expected to drop by about 50% from peak years.

Chuck Masters (Weyerhaeuser)

- The Southern Seed Orchard Pest Management Subcommittee of the Southern Forest Tree Improvement Cooperative in cooperation with the West has prepared a white paper (Appendix D) on the role of the (USDA) Forest Service in seed orchard pest management research with plans to present to the FS, States, and others. The concern is over the decline in resources to deal with seed and cone problems. It is believed that the FS has a legislative mandate to keep the nation's public and private forest lands productive. Decreased harvest of wood from federal lands is increasing pressure on state and private lands. Tree improvement can increase productivity to compensate, but control of cone and seed insects in seed orchards is essential. It is even more important now than before, and movement toward integrated pest management approaches (EPA) is not helping the matter.
- Committee members of the National Steering Committee for Management of Seed, Cone, and Regeneration Insects representing the Northwest met to discuss concerns about the goal selection process and to reach concensus on research and technology development priorities. These priorities were shared with the team.

1. It was suggested that the goals be submitted to the Director of Forest Pest Management be described in broad categories, that would then become guides for funding projects with the greatest return on investment.

2. It was judged that there should be a reasonable split on projects selected for funding that represent both ecosystem management and timber species management. Some projects could have dual role.

3. It is believed that development of a strategic plan by the committee would help with the development of a sound tactical plan.

Nancy Rappaport (PSW)

- Cone abortion study in sugar pine, Badger Hill Italian pistachio tree-seed shortage.

Dave Rising (MTDC)

- Keith Wendell - available to make temperature measurements to support thermal insect control system be evaluated in NW and NA.
- Updated committee on MTDC projects supported by FPM.
- October demonstration GPS/NAV near Missoula, MT.
- Herchulon (pheromone) flakes - application is a problem.

Darrell Ross (OSU)

- Regeneration insect interest - western pine shoot borer. Cooperative agreement with PNW hazard rating model plantations for western pine shoot borer.
- Daterman and Sower - pheromone system has been developed. Will look at pesticides but not for operational control.

Roger Sandquist (R-6)

- Burning flame project with Tim Schowalter.
- Yellow panel technology development money study done.
- WWP highest priority, next sugar pine, western larch, ponderosa pine, lodgepole.
- Restoration activities, minor species needed in nurseries.

Tim Schowalter (OSU)

- Flame study. Mortality increased as temperature and duration increased under dry conditions, Future will try burning in October.

- Discussed canopy diversity, and population.

Bill Sery Oconto River Seed Orchard, 18100 Saul's Spring Rd., White Lake, WI 54491.

- Orchard has many species.

- Problem with method of tagging acorns.

John Taylor (R-8)

- Seed orchard EIS moving along.

- Malathion still available in seed orchards but not general forestry.

- Metasystox is out.

Jack Barry (WO/FPM Davis)

- "Timely Tips" letter - Pat Skyler is editor - please send pesticide and other articles on forest pest management.

- Orchard sanitation non-chemical IPM technique using sweepers and vacuum systems - need to support this concept and seek other innovation pest control methods.

- Peach twig borer - use of Forest Service aerial application technology applying low volumes of Bt by ULV in California is replacing chemical pesticides. State IPM Coordinator requested FS assistance - 2-year project successful.

- Single tree spray system is progressing - need to extend this to other users. Need to do tree coverage tests at volumes of 1, 5, 10, 15, and 20 gpa - look for coverage on cones, needles, leaves. Need project documentation and reports (see Appendix E).

- Note Jim Rafferty's report (Appendix F) on analyses of aerial treatments in Oregon.

D. Other Comments, Observations & Concerns

- Need to review Committee's scope, purpose, and membership.

- If regeneration insects are to be included in agenda then, need more representation?

- Western pine shoot borer, E. gobis. eucalyptus leaf beetle.

- Need message sent to WO on regeneration insect research needs.

- Need to reflect regeneration in our Tactical Plan.

- Issue of priorities - heavy competition for few dollars.

- What are roles and opportunities for seed, cone, and regeneration insect work under EM?

- Inconsistency in funding.

- Proposal - multi-regional and multi-disciplinary. tiered to tactical plan.

- States and industry need to bring forth their needs.

- Industry peer review, if so, needs to be initiated by industry. They need input into FPM's TD review process. Realign review - committee should include S&P.

- Concern that important issues do not get close to being funded.

- We are not doing basic research so need support, many basic questions.

- Pay for travel of non-FS committee members? (Give budget cuts and new philosophy, this is not likely.)

E. Strategic/Tactical Plan Sub-committee

The committee, having decided to pursue development of a strategic/tactical plan to replace or support the committee's existing tactical plan, members representing different geographical areas and organizations, organized a sub-committee to be chaired by Roger Sandquist. The charge of the sub-committee is to develop the plan. Volunteers were:

- Nancy Rappaport - FS, PSW Station, West
- Chuck Masters - Weyerhaeuser Research
- John W. Taylor - FS, FPM, Southeast
- Darrell Ross - Oregon State University (Regeneration insects)
- Steve Katovich - FS, FPM, North Central
- Roger Sandquist - FS, FPM, West

The other committee members attending expressed willingness to assist the committee and it is likely that each of us will be asked to make contributions. Members who missed this meeting should contact Roger Sandquist.

The first order of sub-committee business is to develop a time/subject schedule of events that will lead to timely development of a draft plan and submit the schedule to members of the parent committee. The sub-committee needs to develop a process, decide on plan format, prepare a mission statement, identify strategic statements, and make assignments.

See Appendix G for changes suggested to tactical plan.

F. **FS Research - Seed, Cone, and Regeneration Insect Priorities.**

<u>Dioryctria</u>

. Basic pheromone work, revisit early work in the southeast and start-up work in the west.

. Basic taxonomic work (DNA, isozymes, cytogenetics, and cross-mating studies) in southeast and west.

. New control methods - microbials and behavioral chemicals.

<u>Leptoglossus</u>

. Life, history in the west

. Monitoring, nationwide

. Pheromones, nationwide

. IPM degree day in west

<u>Conophthorus</u>

. ID pheromones for western species

. Taxonomy of western species

. Try-out, push-pull strategies for seed orchards

G. **Single Tree Spray System**

Since the Rhinelander meeting the single tree spray system proposed by Nancy Rappaport continues under development. Updates on single tree spray system field activities are provided in the Appendix E.

H. **Native Plant Materials (See Appendix H).**

III. SUMMARY

The National Steering Committee for Management of Seed, Cone, and Regeneration Insects met at Rhinelander, WI, June 28-30, 1994, hosted by Steve Katovich, FPM, St. Paul Field Office. The purpose of the meeting was to identify FPM Technology Development needs and to discuss updates to the committee's tactical plan. We were successful in meeting these objectives. Sandy Kegley, R-1, volunteered to host the next meeting at Coeur d'Alene, ID, July 11-13, 1995.

APPENDICES

A. Meeting call letter and Agenda

B. Member Reports

C. Committee Technical Development Recommendations 1994

D. Chuck Masters, et al. White Paper

E. Single Tree Spray System - Trip Reports

F. Jim Rafferty Report on Aerial Application to Oregon Seed Orchards

G. Tactical and Strategic Planning Issues

H. R-5 Memorandum - Policy on the Use of Native Plant Material in Restoration

Appendix A

Meeting call letter and Agenda

United States Department of Agriculture
Forest Service
Washington Office
2121 C Second Street
Davis, CA 95616
PH (916) 551-1715
FAX (916) 757-8383

Reply To: 3400

Date: May 10, 1994

Subject: Meeting - National Steering Committee for Management of Seed, Cone, and Regeneration Insects

To: Members

The next meeting of our committee will be held at Rhinelander, Wisconsin, June 28 (Tuesday) through June 30. Hosted by Steve Katovich, St. Paul Field Office, the three day meeting includes a day-long field trip on June 29.

The purpose of the meeting is to:

1. Prioritize technology development needs for FY95;

2. Discuss ecosystem management roles, developments, needs, and opportunities within the context of this committee;

3. Review activities and accomplishments since the Placerville meeting; and

4. Update the 5-Year Tactical Plan.

The meeting will be held at the Best Western Claridge Motor Inn, Rhinelander, (715)362-7100. As I indicated in previous messages, the single room rate is $47.00. I have been informed by Finance and Accounting that we cannot use a tax exempt form in Wisconsin, even though the Claridge will accept tax exempt forms - sorry for the confusion in my prior messages. For transportation options to Rhinelander, Steve has provided the following information: Rhinelander has an airport serviced by commuter aircraft. Flights are available into Rhinelander via Minneapolis/St. Paul and Chicago. You can also fly into an airport called Central Wisconsin Airport. This would also be a commuter flight from Chicago or Minneapolis/St. Paul. It would require a car rental and a 1.5 hour drive north to Rhinelander. The other options are to fly into Minneapolis and rent a car for a 4.5 hour drive to Rhinelander, or Steve can get a group together and drive to Rhinelander in a van. One other option would be to take jet service into Green Bay, Wisconsin and rent a car. Rhinelander is a little over 2 hours from Green Bay. Please call Steve at (612) 649-5261 to coordinate transportation from Minneapolis/St. Paul.

I would appreciate your bringing a hard copy of your annual report to the committee for enclosure to our committee report. Also enclosed is a copy of our 1994 technology development priority needs and the draft agenda. Note that

Jacks

Draft
16 June 94

DRAFT AGENDA

National Steering Committee -
Seed, Cone, and Regeneration Insects

Claridge Motor Inn

Rhinelander, WI

June 28 - 30, 1994

			Discussant Leader
June 28, 1994 Tuesday			
0800	WELCOME		Steve Katovich
	INTRODUCTION		
		Role of Committee and FPM Technology Development Program	Jack Barry
		Purpose of Meeting	
		Review Notes of Placerville Meeting	
		Identify Technology Development Needs For 1995	
		Review activities / accomplishments since Placerville meeting	
		Discuss seed / cone insect white paper	
		Update 5-Year Tactical Plan	
		Agenda - changes?	
		Field trip is on Wednesday	
	DISCUSSIONS		
		Review Committee Scope, Purpose, Charge, and Membership	Members
		Review 1993 Committee Report, Recommendations, and Draft 5-Year Tactical Plan	Jack Barry
		Discussion - Seed and Cone Insect White Paper	Chuck Masters
		Discussion - Seed, Cone and Regeneration Insect Management in Ecosystem and Forest Health Management -	Jed Dewey

	Individual Committee Member Reports/ Accomplishments	Members
1630	Briefing on Field Trip	Steve Katovich
1700	Adjourn	

June 29, 1994	Wednesday	Activity Leader
0730 - 1800	**FIELD TRIP**	Steve Kotovich

1. Oconto River Seed Orchard, Nicolet National Forest, several orchards are located here - demonstrate propane burner for control of cone beetles.
2. Consolidated Paper Corporation - tour containerized seeding facility.
3. Nicolet National Forest - visit old growth forest.
4. Other options depending on time.

June 30, 1994	THURSDAY	Discussant Leader	
0800	**5-YEAR TACTICAL PLAN**		
	Tactical Plans by other Steering Committees	Jack Barry	[illegible]
	Update - Discussion to be Lead by Contact Scientists- Progress Reports, Revision	Contact Scientists	
	Discussion of Priorities	Members	
	Revise Draft	Members	
	Priority Technology Development Needs for 1995	Members	
	Place and Dates of Next Meeting	Members	R-1 [illegible] 11-13 July
[illegible] 1630	Adjourn		

FIELD TRIP - NATIONAL STEERING COMMITTEE FOR MANAGEMENT OF SEED, CONE, AND REGENERATION INSECTS - WEDNESDAY, JUNE 29, 1994

8:00 - Depart from Motel Parking Lot (2 minivans will be available)

8:30 - Visit Consolidated Paper's Monico Greenhouse Facility

Greenhouse facility producing containerized red pine seedlings

Discuss tree improvement program for European larch

Visit field site to observe planting practices using containerized stock

10:30 - Visit the Oconto River Seed Orchard, Nicolet National Forest

Demonstrate propane flamer used for cone beetle control in white pine

Observe and discuss several northern conifer seed orchards

12:00 - Lunch at the Orchard

1:00 - Tour the Lakewood Ranger District, Nicolet National Forest

Observe several recent regeneration projects

Observe an example of northern Wisconsin old-growth forest

4:30 - Return to Rhinelander

Appendix B

Member Reports

Larry R. Barber, R-8

Gary DeBarr, FS Lab

Steve Katovich, NA/FPM

Sandy Kegley, R-1/FPM
Jed Dewey, R-1/FPM

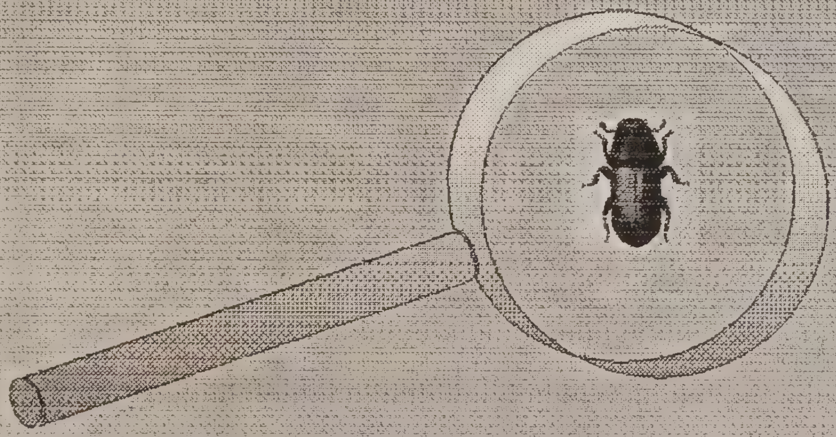
Nancy Rappaport, PSW/FIDR

T. D. Schowalter, OSU

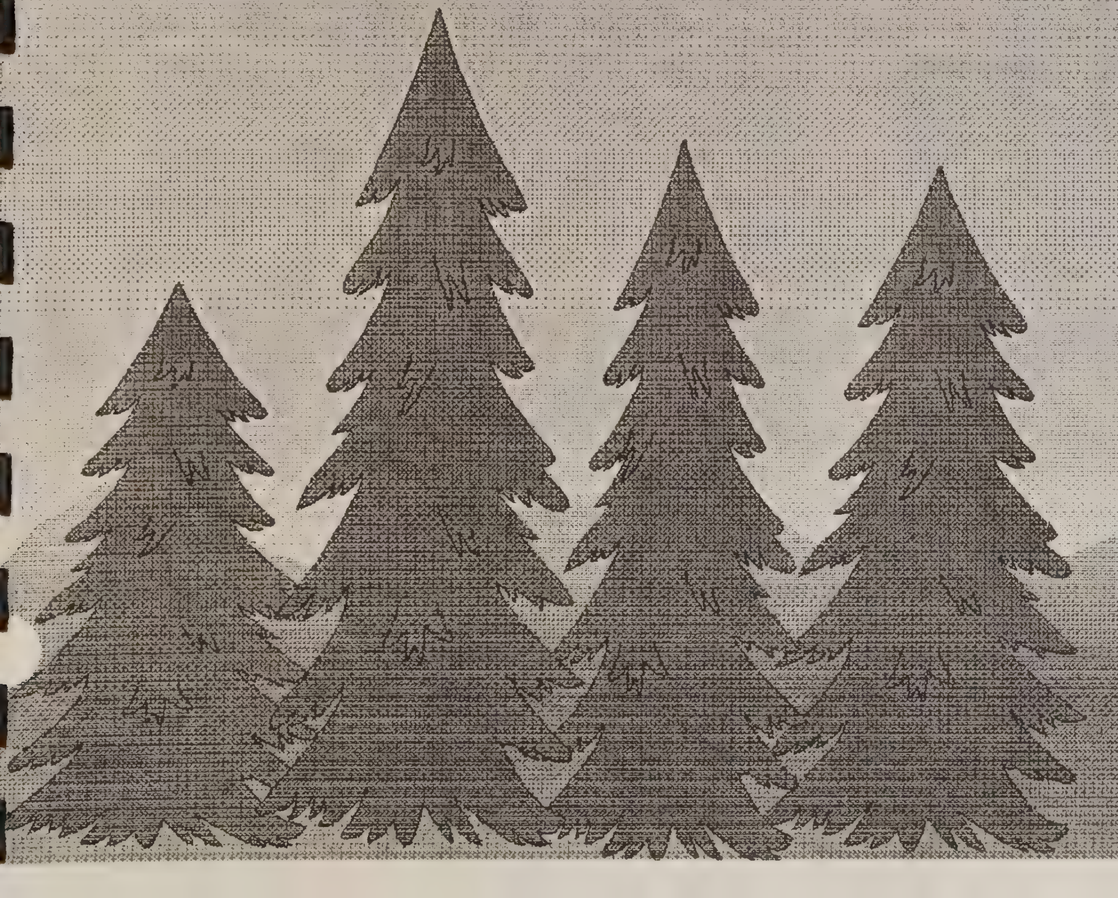
Larry R. Barber, R-8

USDA Forest Service
Forest Health
Report # 94-1-28

An Evaluation of White Pine Cone Beetle Populations North Carolina Division of Forest Resources Edwards Seed Orchard - Morganton, NC 1994



Larry R. Barber
and
Don Rogers



An Evaluation of White Pine Cone Beetle Populations North Carolina Division of Forest Resources Edwards Seed Orchard Morganton, NC 1994

Larry R. Barber[1] and Don Rogers[2]

ABSTRACT

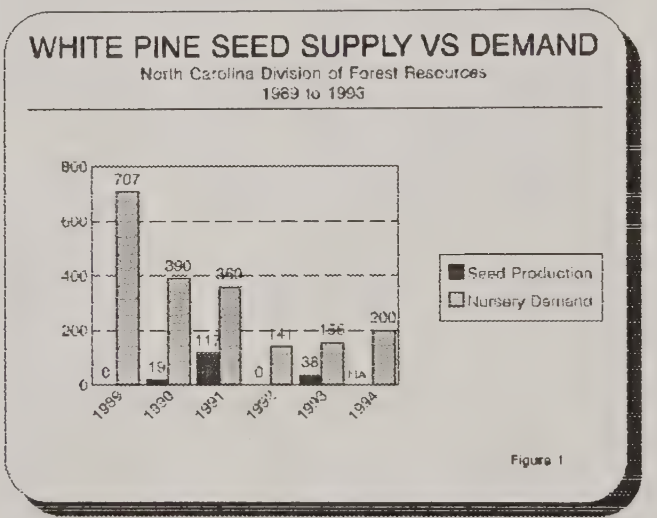
White pine cone beetle populations remain at low levels on the orchard, however, the potential cone crop is threatened by beetle invasion from the surrounding area. Control tactics should include a prescribed fire this year before beetle emergence in at least areas 2A and 9 which adjoin the orchard. For maximum cone production, burn all areas where over-wintering populations of beetles were detected.

INTRODUCTION

The white pine cone beetle, (WPCB) Conophthorus coniperda (Schwarz), is the most damaging pest that attacks white pine cone crops with losses often exceeding 90 percent. In the past few years, entomologists with the USDA Forest Service, Forest Health and the Southeastern Forest Experiment Station have developed ways to control this pest using prescribed fires. Because adult beetles over-winter in dead cones on the ground, a prescribed fire in the orchard duff that raises internal cone temperatures to about 140 degrees Fahrenheit will kill over-wintering populations.

The Edwards Orchard is 23 acres in size and lies along the Catawba River near Morganton, NC. The eastern white pine trees Pinus strobus L. are 60-70 ft. in height and have been in full production for 15 years. The North Carolina Division of Forest Resources depends on the seed from the orchard to sustain their nursery and an active state tree planting program.

Techniques were developed several years ago to monitor beetle populations on orchards and the data for 1989 to 1994 are reported in this paper. Data are used to determine the potential threat to the cone crop and to determine treatments as needed. The Edwards Orchard was treated with prescribed fire from 1990 to 1993. While these fires reduced beetle populations in the orchard, cone and seed production did not increase as expected. Beetle immigration from surrounding white pine plantations and from other factors such as low flower production or ice damage to branches all contributed to lower than expected seed yields. In addition some beetle infested cones remained on the trees and the fire does not kill these insects.



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[1] Entomologist, USDA, Forest Service, Forest Health, Asheville, NC

[2] Forest Pest Control Specialist, NC Division of Forest Resources, Morganton, NC

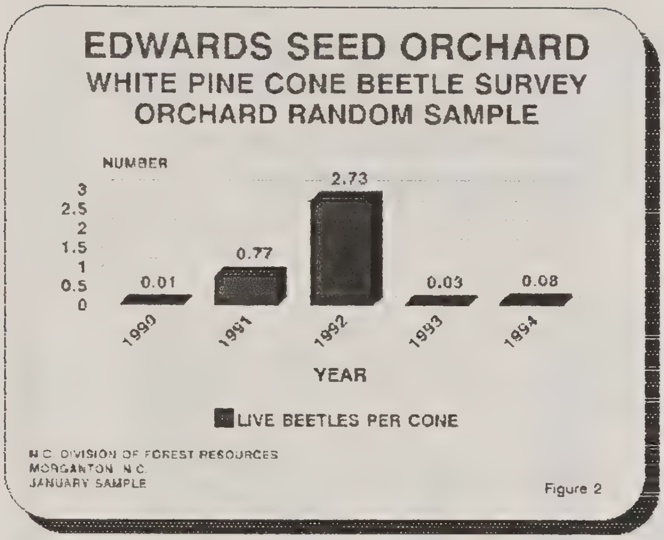


Figure 2

There was no seed production in 1989, however, in 1990 and 1991 yields increased (fig. 1). In 1992 an ice storm and extremely high WPCB populations (fig. 2 and fig.3) reduced seed production to 0 and in 1993 only 38 pounds were collected (fig. 1).

The reasons for the production short fall are many. For example, in 1989 no attempt was made to control the beetle with fire and existing chemical control methods failed. In 1990 the grass was too wet and the smoldering fire killed few beetles. In 1991 the prescribed fire controlled the beetles in the orchard duff but beetle immigration into the orchard from surrounding white pine stands resulted in cone damage of greater than 50 percent on some orchard edge trees.

During this time the nursery was planting decreasing amounts of seed. Unfortunately, the seed orchard was unable to grow enough seed to meet the nursery demand which required the nursery to buy seed.

MATERIALS AND METHODS

Orchard Samples

Annually, 100 cones are selected at random from across the orchard with additional 50 sq. ft. samples from another 20 pre-selected trees.

The two sample methods allow entomologists to monitor population trends over time and to determine the relative number of beetles in each cone and under representative trees. The data is used to predict potential cone damage.

The random sample consists of collecting and dissecting 100 randomly collected but previously beetle infested cones from the litter layer. The 50 sq. ft. sample is taken yearly from 20 selected trees. All dead cones are collected from within the 50 sq. ft. and destructively sampled for live beetles.

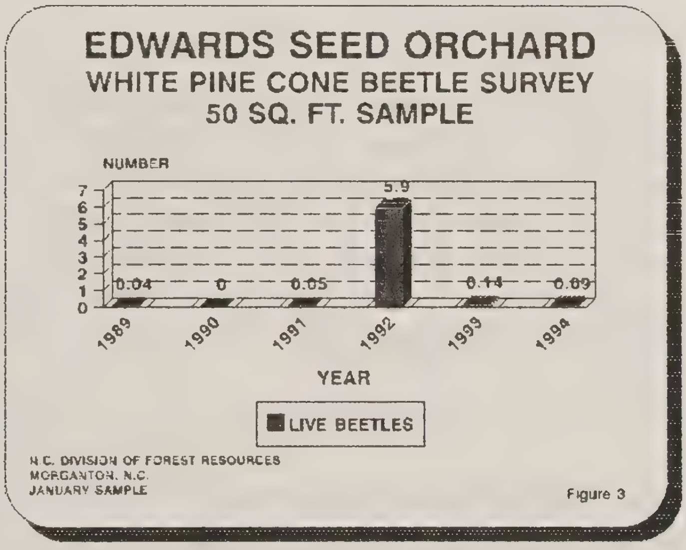


Figure 3

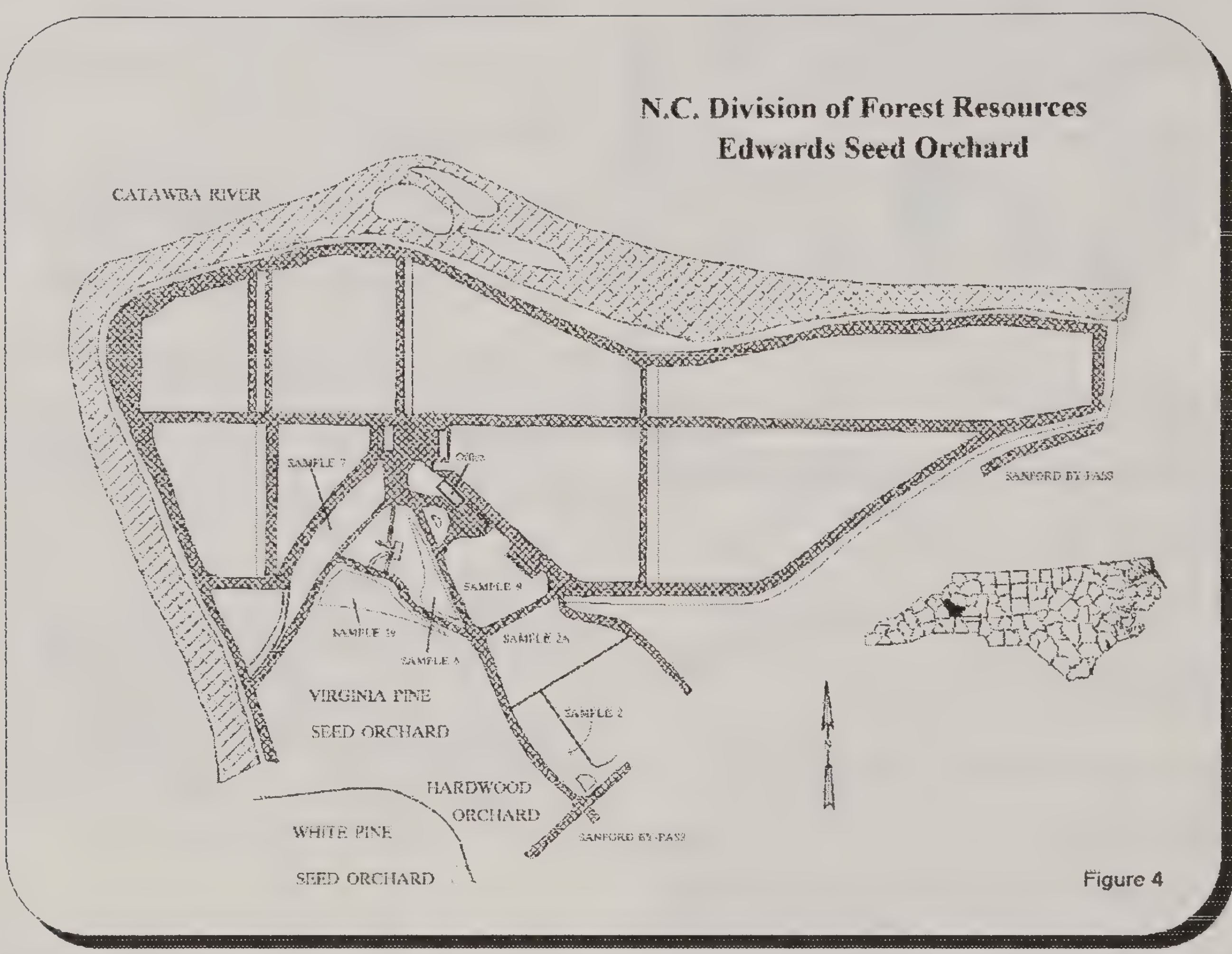


Figure 4

Non Orchard Random Samples

Because WPCB are thought to be strong fliers, and because they are active in the spring when winds are often high, it is important to sample surrounding woodlands containing white pine. Random samples are taken from windbreaks and pine plantations surrounding the Edwards Nursery and Orchard (fig. 4).

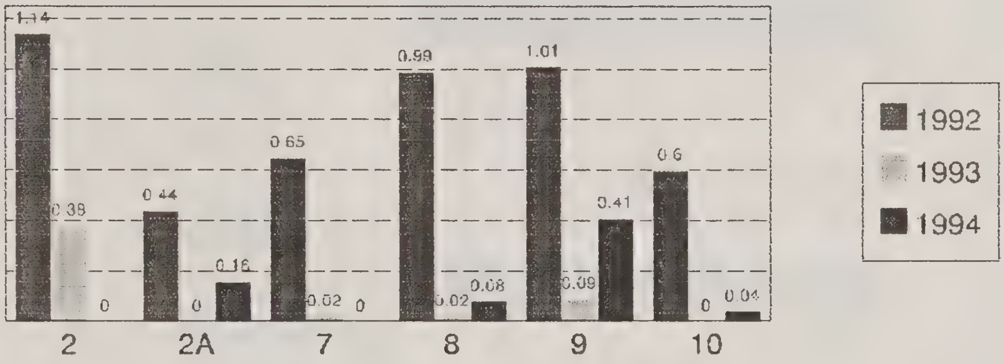
RESULTS

Data from the orchard random and 50 sq. ft. samples indicate that beetle populations are down for the second straight year. Only 0.08 live beetles per cone were detected in the random samples and 0.09 in the 50 sq. ft. samples areas.

This compares to the high in 1992 where beetle populations were 2.73 per cone in random samples and 5.9 beetles in 50 sq. ft. samples. Random samples taken from areas around the orchard indicate varying populations levels from none in sample areas 2 and 7, and up to 0.41 beetles per cone in area 9 which is a woodlot located near the office (fig. 5) .

EDWARDS SEED ORCHARD

WHITE PINE CONE BEETLE SURVEY
RANDOM SAMPLE AREAS



N.C. DIVISION OF FOREST RESOURCES
MORGANTON, N.C.
SAMPLED IN JANUARY

Figure 5

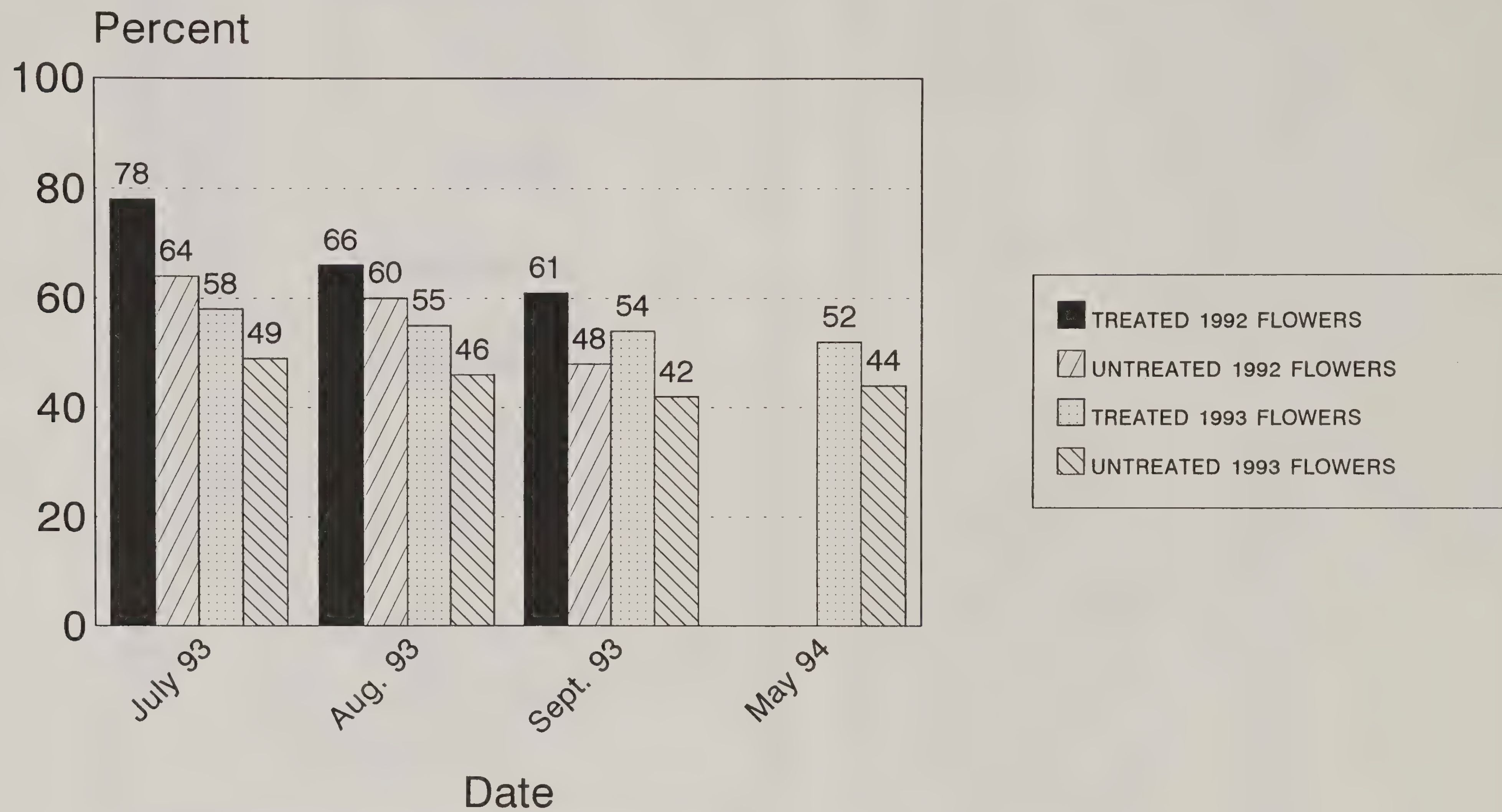
RECOMMENDATIONS

If maximum seed production is needed, management should consider burning the orchard and samples areas 2A, 8, 9, and 10. The highest priority area to burn is sample area 9.

Dr. Gary DeBarr , USDA Forest Service, SEFES, Athens, GA is working on a technique to control the WPCB using pheromones to trapout beetles during low population cycles. The Edwards Orchard may be ideal for this work.

NORTHERN RED OAK SEED ORCHARD

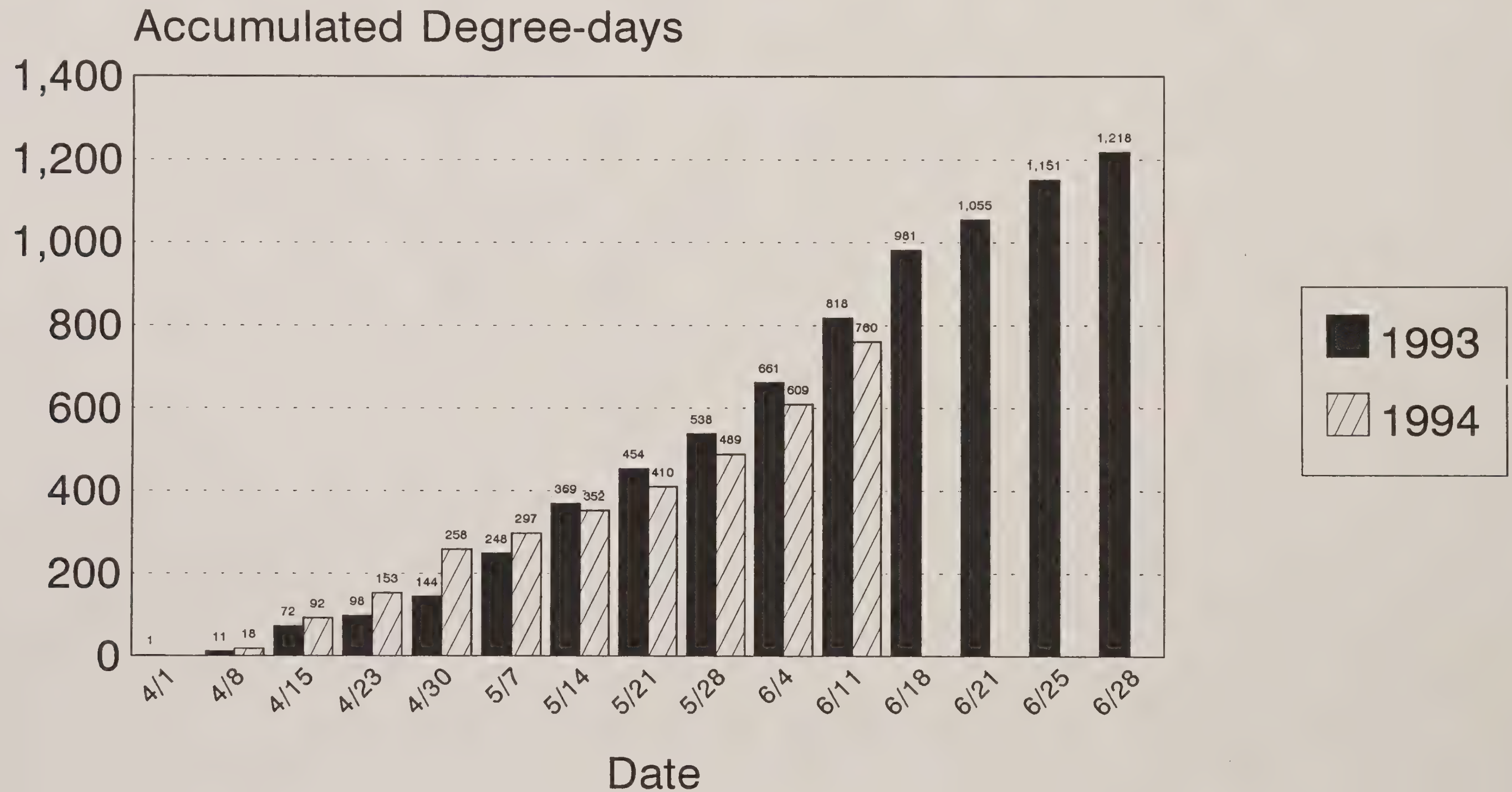
1992-1994 FLOWER SURVIVAL



23 TREES TREATED SIX TIMES WITH ASANA XL, 20 TREES UNTREATED
FROM SEPT. 93 TO MAY 94, HIGH WINDS CAUSED TAG LOSSES OF 51% IN THE TREATED TREES AND 44% IN THE UNTREATED TREES.

FILBERTWORM DEGREE-DAY PROJECTIONS

NORTHERN RED OAK SEED ORCHARD



Expected first emergence 610 (range 580-637)
Expected peak flight 1188 (range 1158-1217)
DD = (Daily Max. + Daily Min. Temperature)/2 - 51 F

Gary DeBarr, FS Lab

A Southwide Test of Bifenthrin (Capture®) for Cone and Seed Insect Control in Seed Orchards

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ABSTRACT. *In 1991, a Southwide study to evaluate the efficacy of bifenthrin (Capture®) for cone and seed insect control was established in six loblolly pine* (Pinus taeda *L.) and three slash pine* (P. elliottii *Engelm.) seed orchards. A control (no treatment), Capture® (bifenthrin), and Guthion® (azinphosmethyl) treatments were established in each seed orchard. Five aerial sprays were used to apply the insecticides during the growing season. At each spray Guthion® was applied at 3 lb ai/ac. Capture® was applied at 0.2 lb ai/ac for the first spray and 0.1 lb ai/ac for the other four sprays. Under the conditions of this study, Capture® was as effective in controlling cone and seed insects as the standard operational Guthion® treatment. Insecticide treatment resulted in a 42% and 17% increase in the number of sound seeds produced per conelet for loblolly and slash pine, respectively. Local need registration (24C) exists in several states, and seed orchard managers can currently use Capture® in Alabama, Arkansas, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina and Tennessee. Seed orchard managers in other southern states need to determine if a 24C label is available in their state prior to useage. South. J. Appl. For. 18(1):72–75.*

Southern pine seed orchards are the source of genetically improved seed used in artificial regeneration programs. Control of cone and seed insects is an integral component of seed orchard management. The major insect pests of seed production are several species of coneworms (*Dioryctria* spp.), the leaffooted pine seed bug (*Leptoglossus corculus* [Say]), and the shieldback pine seed bug (*Tetyra bipunctata* [Herrich-Schaffer]) (Ebel et al. 1980). Without effective control, these insects can easily destroy over 50% of the seed crop and have reduced yields as much as 90% (Fatzinger et al. 1980, Hodge et al. 1992).

Currently, the following insecticides are registered and used extensively for cone and seed insect control: azinphosmethyl (Guthion®)[1], esfenvalerate (Asana®) and permethrin (Ambush® and Pounce®). Although these insecticides are effective, each also has disadvantages. These disadvantages may include a strong odor, high toxicity to mammals and other nontarget organisms, and/or possible contribution to a buildup of secondary insect pests.

To address the current need for registration of additional insecticides that are effective for cone and seed insect control

NOTE: The Seed Orchard Pest Management Subcommittee gratefully acknowledges the assistance of the supporting organizations in completing the Southwide Capture® Study. This project could not have been completed without the assistance of the organizations that donated seed orchards and staff to complete the study. Orchard managers involved in the study were Jake Clark—Bowater, Inc., Mike Young—Georgia Forestry Commission, Keith Palmer—Georgia Pacific Corp, French Wynne, Jr.,—Potlatch Corp., Larry Miller—Temple-Inland Forest Products, Jerry Windham—USDA Forest Service, and Loran Clark—Georgia Pacific Corp. A major share of the credit for completion of this study belongs to these people and their staff. The assistance of Gary Hancock and FMC in obtaining the required permits and supplying the Capture® is greatly appreciated.

[1]The mention of trade names is solely to identify material used. All pesticides must be registered by the appropriate state and federal agencies before use.

Reprinted from the *Southern Journal of Applied Forestry,* Vol. 18, No. 2, May 1994.

United States Department of Agriculture
Forest Service
SE
Forestry Sciences Lab
320 Green Street
Athens, GA 30602-2044

28 April 1994

Francis Lewis
Weyerhaeuser Company
Route 1, Box 108
Eutaw, Alabama 35462

Dear Francis:

We completed installation of the 1994 Systemic Insecticide Study in the Flatwoods Seed Orchard last week. A total of 108 trees representing 9 clones were used for our study. The following treatments are being tested:

Treatment Number	Insecticide	Application Method
1	Control	Drill-Hole
2	Orthene®	Drill-Hole
3	Orthene®	Medicap
4	Admire®1X	Drill-Hole
5	Admire®0.5X	Drill-Hole
6	Admire®0.25X	Drill-Hole
7	Admire®0.125X	Drill-Hole
8	Admire®	Medicap
9	Admire® 1%	Bark Spray
10	Align®1X	Drill-Hole
11	Align®0.5X	Drill-Hole
12	Align®0.25X	Drill-Hole

DEBARR

PHEROMONES IN THE WHITE PINE CONE BEETLE, *Conophthorus coniperda* (SCHWARZ) (COLEOPTERA: SCOLYTIDAE)

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ABSTRACT--Females of the white pine cone beetle, *Conophthorus coniperda*, attacking second-year cones of eastern white pine, *Pinus strobus* L., produced a sex-specific pheromone that attracted conspecific males in laboratory bioassays and to traps in the field. Beetle response was enhanced by host monoterpenes. The female-produced compound was identified in aerations collected on Porapak Q® and in hindgut extracts as (+)-*trans*-pityol, (2R,5S)-2-(1-hydroxy-1-methylethyl)-5-methyltetrahydrofuran. Males and females produced and released (*E*)-(+)-spiroacetal, (5S,7S)-7-methyl-1,6-dioxaspiro[4.5]-decane, which was not an attractant for either sex, but acted as an inhibitor for males. Porapak Q® extracts of both sexes produced (+)-*trans*-pinocarveol and (–)-myrtenol. In addition, hindgut extracts of females contained *trans*-verbenol, while males had pinocarvone and verbenone. Work in Georgia and Canada confirmed that the same isomers of pityol and spiroacetal are present in two distinct and widely separated populations of *C. coniperda*.

Key words: *Conophthorus coniperda*, white pine cone beetle, Scolytidae, pheromone, pityol, 2-(1-hydroxy-1-methylethyl)-5-methyltetrahydrofuran, *E*-7-methyl-1,6-dioxaspiro[4.5]-decane, spiroacetal, chiral analysis, walking bioassay, traps

Running title: Pheromone candidates in *Conophthorus coniperda*

INTRODUCTION

The white pine cone beetle (WPCB), *Conophthorus coniperda* (Schwarz) (Coleoptera: Scolytidae), occurs throughout the range of eastern white pine, *Pinus strobus*, L. and is rarely found on other hosts (Wood, 1982). It is the most serious insect pest of eastern white pine seeds in natural stands (Godwin and Odell, 1965; Hedlin *et al.*, 1980) and seed orchards (DeBarr *et al.*, 1982).

Volatiles are commonly used by scolytids for locating suitable hosts or mates (Borden, 1985). However, little is known about the responses of *Conophthorus* spp. to either pheromones or odors released by cones. Beetle-infested cones and their monoterpenes attracted male and female ponderosa pine cone beetles, *C. ponderosae* Hopkins, in laboratory bioassays (Kinzer *et al.*, 1972; and Kinzer and Reeves 1976). However, Mattson *et al.* (1984) and Mattson and Strauss (1986) rejected the hypothesis of cone-directed alightment by the red pine cone beetle (RPCB), *C. resinosae* Hopkins, in response to cone-produced volatiles.

Recently, we reported evidence for a female-produced sex pheromone which attracts WPCB and RPCB males to their cone galleries (de Groot *et al.*, 1991). Here we describe the isolation and identification of both female- and male-produced volatiles from airborne collections and hindguts of WPCB. Laboratory bioassays and field trapping were used to determine beetle response to host and beetle-produced volatiles and to compounds identified as pheromone candidates. Volatiles from beetles and beetle-infested cones were analyzed in the United States to identify pheromone candidates. Analyses in Canada were aimed at clarifying taxonomic relationships for three sympatric *Conophthorus* species (de

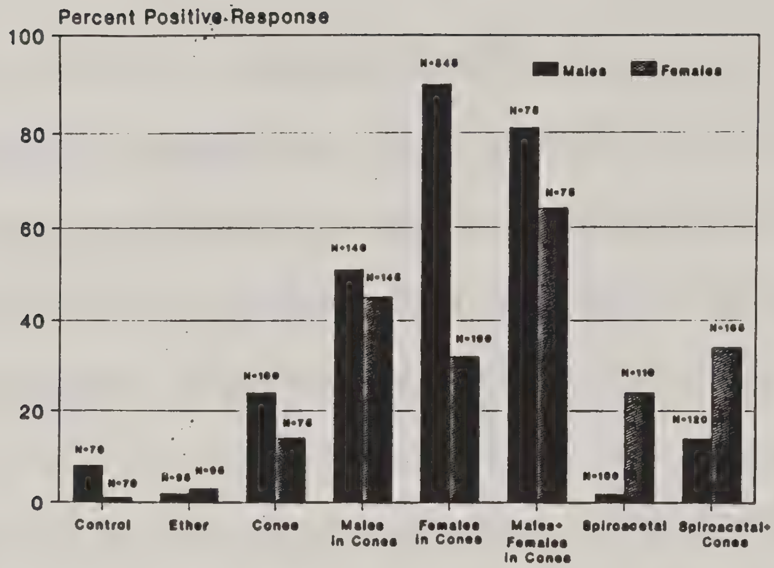


Table 2.– Treatments tested for olfactory responses by male and female *C. coniperda* to combinations (Bioassay 2) and single deletion (= Subtractive; Bioassay 3) of beetle or host-produced volatiles–Athens, GA, 1990.

Treat.	Aeration of females in cones	Female compounds				Host volatiles			Male compound
		Pit[1]	Pit[2]	tP	Mt	CE	MT	BorAc	Leperisin
Bioassay 2									
CT	-	-	-	-	-	-	-	-	-
1	-	+	-	-	-	-	-	-	-
2	-	-	+	-	-	-	-	-	-
3	-	+	-	+	+	-	-	-	-
4	-	-	+	+	+	-	-	-	-
5	-	-	+	+	+	-	-	-	+
6	-	-	+	+	+	+	-	-	-
7	-	-	+	+	+	-	+	-	-
FE	+	-	-	-	-	-	-	-	-
Bioassay 3									
1	-	-	-	+	+	+	-	-	-
2	-	-	+	-	+	+	-	-	-
3	-	-	+	+	-	+	-	-	-
4	-	-	+	+	+	+	-	-	-
5	-	-	+	+	+	-	+	-	-
6	-	-	+	+	+	-	-	+	-
7	-	-	-	+	+	-	+	+	-
8	-	-	+	-	+	-	+	+	-
9	-	-	+	+	-	-	+	+	-
10	-	-	+	+	+	-	+	+	-
FE	+	-	-	-	-	-	-	-	-

[1]Pit= (±)-*trans*-pityol (Made by K. Mori)
[2]Pit= (+)-*trans*-pityol (Made by H. Pierce)
tP= (+)-*trans*-pinocarveol
Mt= (–)-myrtenol
CE= extract of volatiles from aeration of cones
MT= synthetic monoterpene hydrocarbons (mixture of α-pinene, β-pinene, myrcene, limonene 1:1:1:1; Aldrich)
BorAc= bornyl acetate (Aldrich)
Leperisin= *E*-(±)-7-methyl-6-dioxaspiro [4.5]-decane (racemic) (Made by W. Francke)
CT= control (air only)
FE= extract of volatiles from aerations of cones infested with females.

Table 5.-- Responses by female and male *C. coniperda* to various combinations of beetle and host-produced volatiles in Bioassay 2 -- Athens, GA, 1990.

Single df comparisons:	Females (%) N	Females (%) ($\bar{x}$ ± SE)	Females (%) P>F	Males (%) N	Males (%) ($\bar{x}$ ± SE)	Males (%) P>F
(±)-*trans*-pityol vs.	--	--	--	29	22 ± 9	0.1237 NS[a]
Control[b]	--	--		13	0 ± 0	
(+)-*trans*-pityol vs.	29	18 ± 9	0.5659 NS	28	24 ± 8	0.8429 NS
(±)-*trans*-pityol	15	27 ± 18		29	22 ± 9	
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol vs.	24	25 ± 7	0.9645 NS	26	33 ± 8	0.4347 NS
(+) pityol	29	18 ± 9		28	24 ± 8	
(±)-*trans*-pityol + *trans*-pinocarveol + myrtenol vs.	24	26 ± 9	0.9386 NS	29	31 ± 8	0.8328 NS
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol	24	25 ± 7		26	33 ± 8	
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol + (±)-(*E*)-leperisin vs.	25	28 ± 10	0.8172 NS	25	8 ± 5	0.0432 NS
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol	24	25 ± 7		26	33 ± 8	
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol + cones volatiles[c] vs.	41	49 ± 11	0.0344 NS	50	91 ± 5	0.0001*
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol	24	25 ± 7		26	33 ± 8	
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol + monoterpenes[d] vs.	37	23 ± 12	0.0093 NS	36	84 ± 5	0.4532 NS
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol + cones volatiles	41	49 ± 11		50	91 ± 5	
(+)-*trans*-pityol + *trans*-pinocarveol + myrtenol + monoterpenes vs.	37	23 ± 12	0.0001*	36	84 ± 5	0.1417 NS
Volatiles from *C. coniperda* females in cones[e]	51	82 ± 7		124	96 ± 2	

[a] NS = not significant; * = significant at P < 0.05, where the comparison-wise α = 0.0034 for each of the 15 comparisons (Sidak 1967, Games 1977).

[b] Control = air only; not tested for females.

[c] Extract of volatiles from aerations of cones.

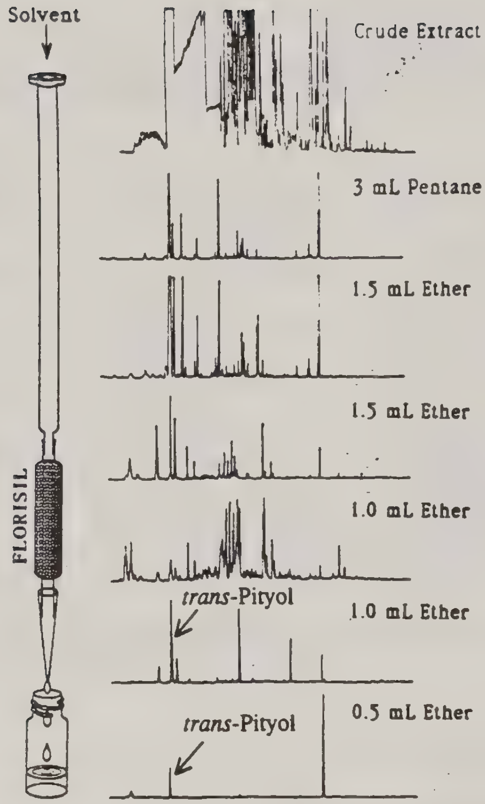
[d] Four major monoterpene hydrocarbon volatiles from *P. strobus* cones (α-pinene, ß-pinene, myrcene, limonene 1:1:1:1)

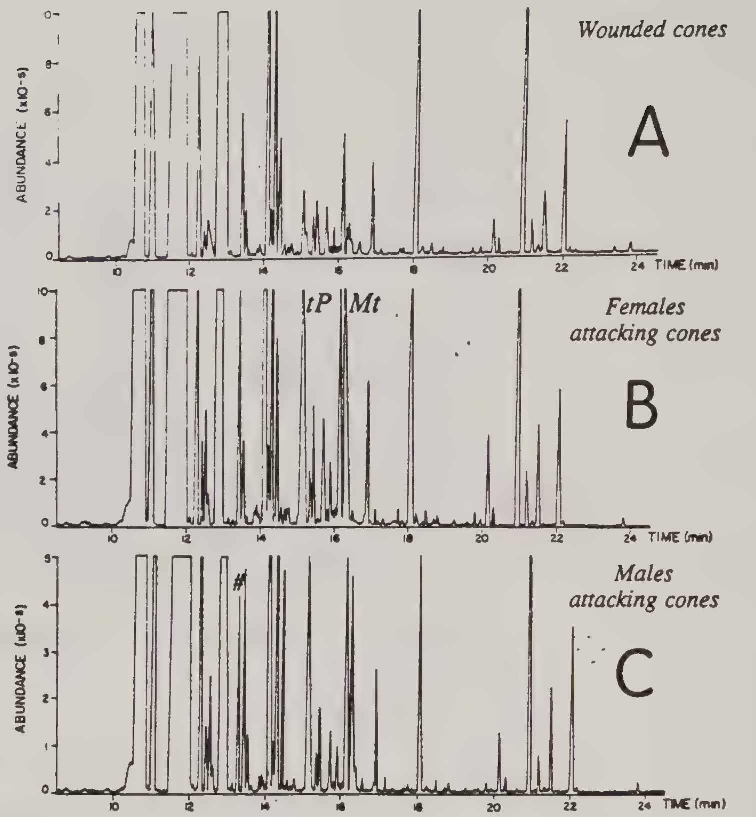
[e] Extract of volatiles from aerations of cones infested with females.

Table 6.-- Responses by female and male *C. coniperda* to single deletions from mixtures of beetle or host-produced volatiles in Bioassay 3 -- Athens, GA, 1990

Single df comparisons:	Females (%) N	Females (%) ($\bar{x}$ ± SE)	Females (%) P>F	Males (%) N	Males (%) ($\bar{x}$ ± SE)	Males (%) P>F
Mixture 1[b] − *trans*-pityol vs.	13	23 ± 2	0.0878 NS[a]	10	20 ± 0	0.0001*
Mixture 1	41	49 ± 11		50	91 ± 5	
Mixture 1 − *trans*-pinocarveol vs.	10	10 ± 10	0.0288 NS	10	70 ± 3	0.2335 NS
Mixture 1	41	49 ± 11		50	91 ± 5	
Mixture 1 − myrtenol vs.	24	13 ± 8	0.0051 NS	24	100 ± 0	0.4591 NS
Mixture 1	41	49 ± 11		50	91 ± 5	
Mixture 2[c] − bornyl acetate vs.	37	23 ± 12	0.0192 NS	36	84 ± 5	0.4984 NS
Mixture 1	41	49 ± 11		50	91 ± 5	
Mixture 2 − monoterpenes vs.	19	5 ± 5	0.1952 NS	23	38 ± 10	0.0007*
Mixture 2 − bornyl acetate	37	23 ± 12		36	84 ± 5	
Mixture 2 − monoterpenes vs.	19	5 ± 5	0.0459 NS	23	38 ± 10	0.0035 NS
Mixture 2	19	38 ± 18		23	81 ± 15	
Mixture 2 − *trans*-pityol vs.	9	25 ± 25	0.5259 NS	9	20 ± 20	0.0019*
Mixture 2	19	38 ± 18		23	81 ± 15	
Mixture 2 − *trans*-penocarveol vs.	13	30 ± 15	0.6659 NS	10	100 ± 0	0.2543 NS
Mixture 2	19	38 ± 18		23	81 ± 15	
Mixture 2 − myrtenol vs.	8	43 ± 23	0.7670 NS	10	50 ± 10	0.1060 NS
Mixture 2	19	38 ± 18		23	81 ± 15	
Mixture 2 − bornyl acetate vs.	37	23 ± 12	0.3033 NS	36	84 ± 5	0.8319 NS
Mixture 2	19	38 ± 18		23	81 ± 15	
Mixture 2 vs.	–	–	–	36	81 ± 15	0.0645 NS
Volatiles from females in cones[d]	–	–	–	52	100 ± 0	

[a] NS = not significant; * = significant at P < 0.05, where the comparison-wise α = 0.0024 for each of the 21 comparisons (Sidak 1967, Games 1977).
[b] Mixture 1 = *trans*-pityol + *trans*-pinocarveol + myrtenol + cone volatiles.
[c] Mixture 2 = *trans*-pityol + *trans*-pinocarveol + myrtenol + monoterpenes + bornyl acetate.
[d] Volatiles from aeration of cones infested with females.


Solvent
FLORISIL
Crude Extract
3 mL Pentane
1.5 mL Ether
1.5 mL Ether
1.0 mL Ether
trans-Pityol
1.0 mL Ether
trans-Pityol
0.5 mL Ether


Wounded cones
A
ABUNDANCE (x10-5)
TIME (min)
tP
Mt
Females
attacking cones
B
ABUNDANCE (x10-5)
TIME (min)
#
Males
attacking cones
C
ABUNDANCE (x10-5)
TIME (min)

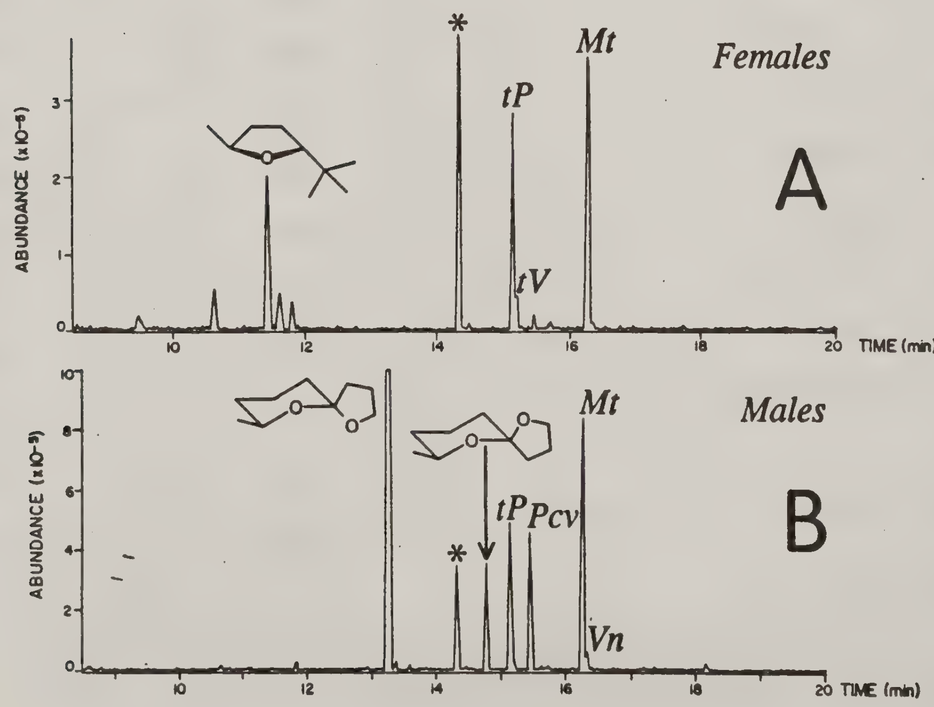
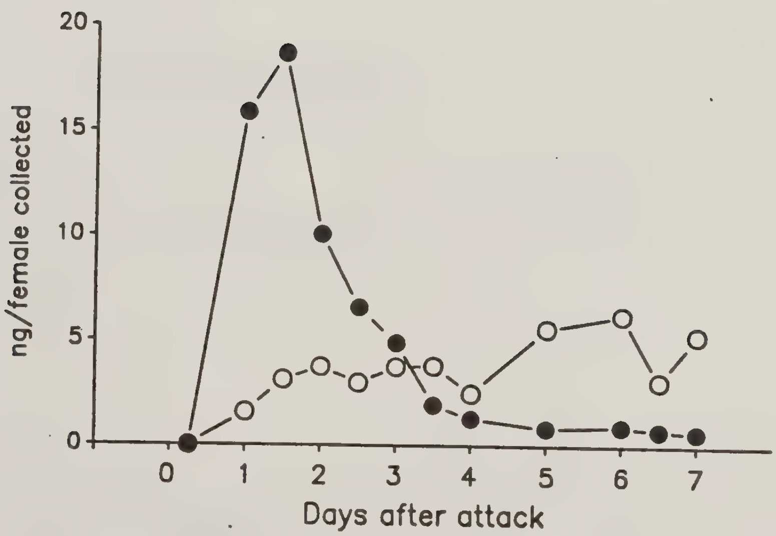

*
Mt
tP
tV
Females
A
ABUNDANCE (x10-5)
TIME (min)
Mt
Males
*
tP
Pcv
Vn
B
ABUNDANCE (x10-5)
TIME (min)

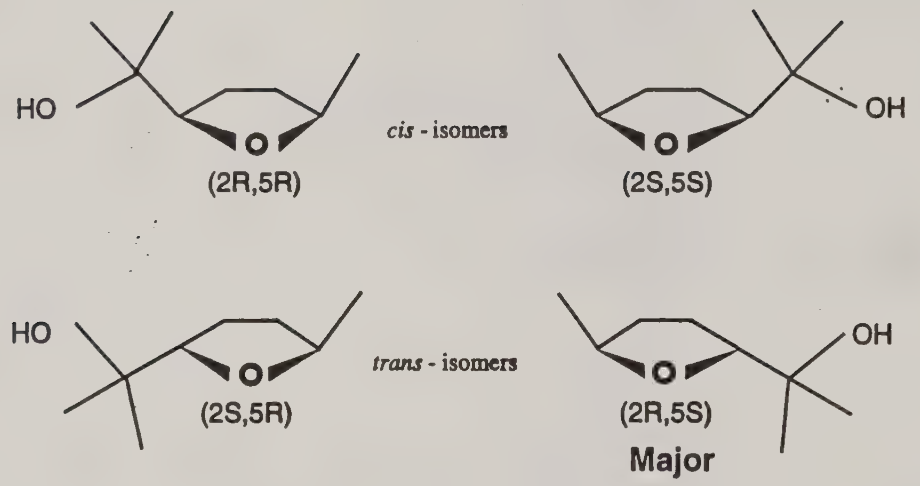
Table 3. Average amounts of compounds identified in hindgut extracts of *C. coniperda* singly attacking new cones. (Group IV)

Compound	ng/beetle[1] Females	Males
α-Pinene	3.7	1.1
(+)-(2R,5S)-Pityol	12.5	–
ß-Pinene	2.9	1.3
Myrcene	1.6	+
(5R,7S)-7-Methyl-1,6-dioxaspiro[4.5]decane	(+)	256
(5R,7S)-Methyl-1,6-dioxaspiro[4.5]decane	–	16.2
(+)-*trans*-Pinocarveol[2]	13.3	24.3
trans-Verbenol	1.7	+
trans-Pinocarvone	0.9	22.0
Isopinocamphone	+	0.1
Borneol	+	+
Myrtenol	–	0.7
(–)-Myrtenol[2]	15.5	40.5
Verbenone	–	1.7

[1] + = Trace of identified compound, but below limit of quantification (LOQ). LOQ = 0.5 ng/beetle.
(+) = trace of prominent MS-fragment present (EICP).
– = below limit of detection (LOD). LOD = < 0.05 ng/beetle by using EICP.
[2] chiral analysis only on male hindgut extract.

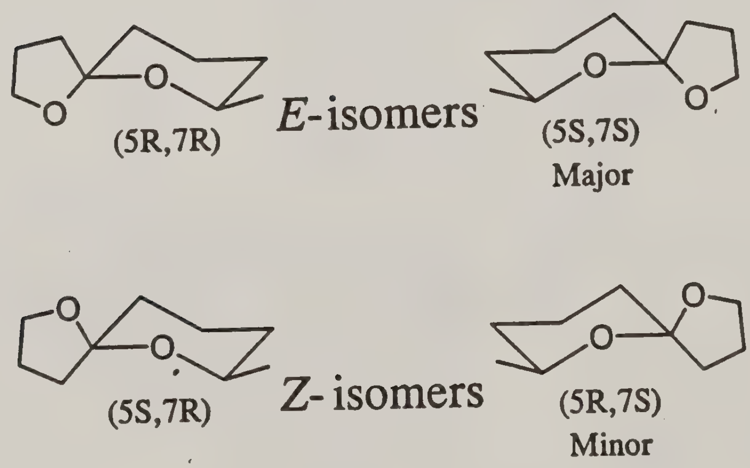


Pityol



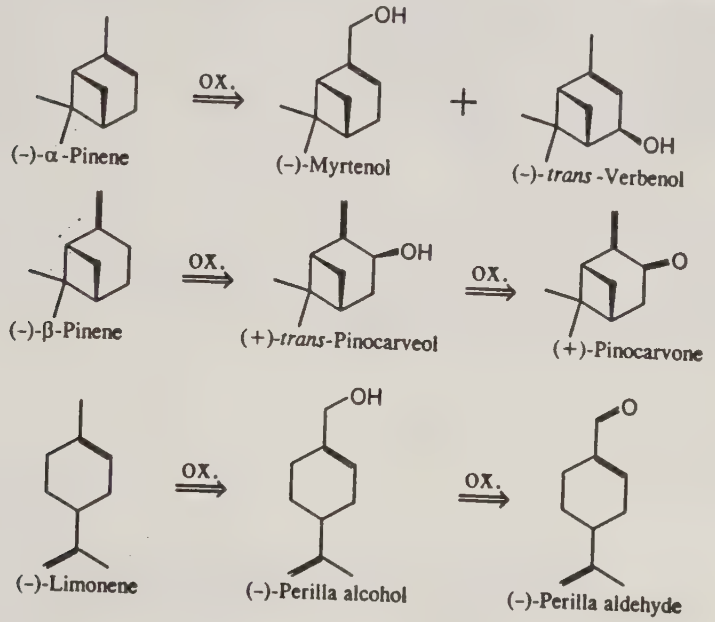
2-(1-Hydroxy-1-methylethyl)-5-methyltetrahydrofuran

Spiroacetal



7-Methyl-1,6-dioxaspiro[4.5]decane

Monoterpene metabolism in the White Pine Cone Beetle



Introduction

The white pine cone beetle, Conophthorus coniperda (Schwarz) (Coleoptera: Scolytidae) (Figure 1), is found throughout the range of eastern white pine, Pinus strobus L., in North America (Figure 2). It is the most destructive pest of white pine cones in seed orchards (Figure 3), which have been established to provide genetically improved seed (Figure 4).

Female beetles initiate cone attack and produce a pitch tube near the base of the second-year cone (Figure 5). Laboratory bioassays and field tests with beetle-produced volatiles provided evidence that females produced a sex pheromone to attract males to the galleries in the cone (de Groot et al. 1991). The female-produced pheromone has been identified as (+) -*trans*-pityol, (2R,5S)-2-(1-hydroxyl-1-methylethyl)-5-methyltetrahydrofuran (Figure 6) (Birgersson et al. 1994).

Here we report the results of field studies to develop *trans*-pityol as a pest management tool. Specifically, we determined if (±)-*trans*-pityol was as effective as (+)-*trans*-pityol, if the addition of α pinene, β pinene, limonene, or myrcene, alone, or in combination, to traps baited with(±)-*trans*-pityol enhanced trap catch, and the effects of trap height on trap catch.

Methods

Study sites: Experiments were conducted in a natural white pine forest in Pancake Bay Provincial Park, near Sault Ste. Marie, ON, and in seed orchards near Murphy, NC, Morganton, NC, Gifford, OH and Buckingham, VI.

Chemicals: (+)-*trans*-pityol and (±)-*trans*-pityol were made by H.D. Pierce Jr., Simon Fraser University, Burnaby BC, and α pinene, β pinene, limonene, or myrcene were obtained from Aldrich Chemical Co., Milwaukee WI.

Traps and chemical releasers: Black 12-unit multiple-funnel traps (Lindgren 1983) (Figure 7) or yellow Japanese beetle trap tops (Trécé Inc., Salinas, CA) fitted with plastic Mason jar bottoms containing 25 ml of ethylene glycol (Figure 8) were used. Chemicals were formulated in 2 ml of n-octane and released from 5-cm cotton wicks within 1.6 mm ID Teflon® tubing inserted through a hole cut in the screw-top of 2 ml glass vials.

Experimental design and analysis: Treatments assigned at random in a block design, and treatment locations were randomized at weekly intervals after the traps were rebaited. Captured beetles were removed from the traps weekly, preserved in 70% alcohol, and identified by species and sex. Trap height data were analyzed by the Mann-Whitney two-sample *t*-test. The data from the other experiments were analyzed using the Rank and GLM procedures (SAS Institute 1985). Planned, non-orthogonal single degree of freedom contrasts were tested only when the F-test was significant, and an experiment wise α of 0.05 was maintained by using Sidak's inequality.

Table 1. Comparison of mean numbers of C. coniperda caught in barrier traps baited with (+)-*trans*-pityol and (±)-*trans*-pityol at Pancake Bay Provincial Park, Ontario

Treatment [b]	Number of beetles captured/trap [a] ($\bar{x} \pm SE$)[c] Females		Males	
(+) pityol vs. unbaited traps	0.1 ± 0.1 0.0 ± 0.0	NS	6.1 ± 1.8 0.0 ± 0.0	*
(±) pityol vs. unbaited traps	0.1 ± 0.1 0.0 ± 0.0	NS	5.9 ± 1.7 0.0 ± 0.0	*
(+) pityol vs. (±) pityol	0.1 ± 0.1 0.1 ± 0.1	NS	6.1 ± 1.8 5.9 ± 1.7	NS

[a] 10 traps per treatment, 28 May - 4 June, 1990
[b] Planned non-orthogonal single degree of freedom contrasts, experiment wise $\alpha = 0.05$
[c] NS = not significant; * = significant at $P < 0.05$

Table 2. Comparison of mean numbers of male C. coniperda caught in barrier traps baited with (±)-*trans*-pityol and host monoterpenes at Pancake Bay Provincial Park, Ontario

Treatment [b]	Number of males captured/trap [a] ($\bar{x} \pm SE$)[c]	
(±) pityol vs. unbaited traps	3.0 ± 2.1 0.1 ± 0.1	NS
(±) pityol + MT[d] vs. (±) pityol	11.3 ± 3.0 3.0 ± 2.1	*
(±) pityol + MT vs. unbaited traps	11.3 ± 3.0 0.1 ± 0.1	*
(±) pityol + MT (- α pinene) vs. (±) pityol + MT	8.6 ± 3.3 11.3 ± 3.0	NS
(±) pityol + MT (- β pinene) vs. (±) pityol + MT	11.3 ± 4.6 11.3 ± 3.0	NS
(±) pityol + MT (- myrcene) vs. (±) pityol + MT	4.5 ± 2.0 11.3 ± 3.0	NS
(±) pityol + MT (- limonene) vs. (±) pityol + MT	11.4 ± 4.7 1.3 ± 3.0	NS

[a] 6 traps per treatment, 14 May - 4 June, 1991
[b] Planned non-orthogonal single degree of freedom contrasts, experiment wise $\alpha = 0.05$
[c] NS = not significant; * = significant at $P < 0.05$
[d] MT = four major monoterpene hydrocarbons from P. strobus cones (α pinene, β pinene, myrcene, limonene 1:1:1:1)

Table 4. Comparison of the mean numbers of male C. coniperda caught in Japanese beetle traps and 12 unit multiple funnel traps baited with (±)-*trans*-pityol placed at 2 m above ground (low) and in the cone bearing region of the tree (high) at Beech Creek seed orchard, Murphy, NC

Treatment [b]	Number of males captured/trap [a] ($\bar{x} \pm$ SE) [c]	
Japanese beetle trap low vs.	0.0 ± 0.0	*
Japanese beetle trap high	9.0 ± 1.0	
12-unit multiple-funnel trap low vs.	0.1 ± 0.1	*
12-unit multiple-funnel trap high	0.4 ± 0.1	

a 6 traps per treatment, 14 April - 6 June, 1992
b Mann-Whitney two-sample *t*-test
c * = significant at P < 0.05

Table 3. Comparison of mean numbers of male C. coniperda caught in 12-unit multiple funnel traps baited with (±)-*trans*-pityol and host monoterpenes at three eastern white pine seed orchards

Treatment [b]	Number of males captured/trap [a] ($\bar{x} \pm$ SE) [e] Morganton NC		Gifford OH		Buckingham VI	
10 FE (±) pityol[c] + 10 MT[d] vs.	1.5 ± 0.7	*	2.0 ± 0.2	NS	1.0 ± 0.4	*
100 FE (±) pityol + 100 MT	3.8 2.6		5.9 ± 3.7		1.3 ± 0.4	
100 FE (±) pityol + 100 MT vs.	3.8 ± 2.6	*	5.9 ± 3.7	*	1.3 ± 0.4	*
1000 FE (±) pityol + 1000 MT	6.5 ± 2.5		23.9 ± 2.5		1.9 ± 0.4	
10 FE (±) pityol + 10 MT vs.	1.5 ± 0.7	*	2.0 ± 0.2	*	1.0 ± 0.4	*
1000 FE (±) pityol + 1000 MT	6.5 ± 2.5		23.9 ± 2.5		1.9 ± 0.4	
100 FE (±) pityol + 100 α pinene[f] vs.	14.8 ± 3.8	*	15.1 ± 1.1	NS	4.3 ± 0.1	*
1000 FE (±) pityol + 1000 MT	6.5 ± 2.5		23.9 ± 2.5		1.9 ± 0.4	
100 FE (±) pityol + 100 α pinene vs.	14.8 ± 3.8	*	15.1 ± 1.1	*	4.3 ± 0.1	*
Unbaited traps	0.6 ± 0.2		0.2 ± 0.2		0.2 ± 0.1	

a 2 traps per treatment, Morganton 11 April - 24 May, 1991; Gifford 25 April - 7 June, 1991; Buckingham 17 April - 29 May 1991
b Planned non-orthogonal single degree of freedom contrasts, experiment wise α = 0.05
c FE = Female Equivalent, where 1 FE = 0.00667 mg/wk
d MT = four major monoterpene hydrocarbons from P. strobus cones (α pinene, β pinene, myrcene, limonene 1:1:1:1), where 1 MT = 1 mg/wk
e NS = not significant; * = significant at P < 0.05
f 100 mg/wk of α pinene

Summary and Conclusions

1. (±)-*trans*-pityol was as effective as (+)-*trans*-pityol, and clearly was an attractant for male, but not female C. coniperda (Table 1).

2. Adding the monoterpenes α pinene, β pinene, limonene, or myrcene, significantly enhanced the catch in traps baited with (±)-*trans*-pityol, but removing any one from an equal mixture does not significantly reduce trap catch (Table 2).

3. Increasing the amount of pityol and the 4 monoterpenes significantly increased trap catch in 8 out of 9 tests (Table 3). Pityol released at 0.7 mg/wk baited with α pinene released at 100 mg/wk caught as many, or more, beetles than pityol released at 7.0 mg/wk when baited with 1 g/wk of a 1:1:1:1 mixture of α pinene, β pinene, limonene, and myrcene (Table 3).

4. Traps placed within the cone bearing region of the tree caught significantly more beetles than those placed at 2m (Table 4). Trap design may also influence the trap catch, but further work is necessary to separate the effects of trap colour from trap design (Table 4).

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Steve Katovich, NA/FPM

Operation of a Propane Flamer for Control of White Pine Cone Beetles in a Seed Orchard

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Oconto River Seed orchard

DRAFT

Introduction

The white pine cone beetle, *Conophthorus coniperda* (Schwarz) is the most destructive seed and cone insect of eastern white pine, *Pinus strobus* L.. Losses approaching 90-100 percent of a cone crop have been reported (Graber 1964, Wade et al. 1989). Therefore, suppression of cone beetles has been required in many seed orchards in order to obtain a seed crop. Satisfactory control was reported using the systemic insecticide carbofuran (Furadan^R) (DeBarr et al. 1982). However, this insecticide is no longer available for use in pine seed orchards and other insecticides have not been reliable in controlling the white pine cone beetle. The lack of available insecticides and the general concerns that exist with insecticide use, have made the search for non-chemical control alternatives a high priority.

White pine cone beetles initiate attacks on cones in the early spring. Female beetles construct an egg gallery in the axis of a developing cone. Infested cones die and eventually drop to the ground. Larval development and pupation is completed within cones during the summer and the new adults remain in the infested cones until the following spring. The presence of infested cones on the ground provides an opportunity to directly kill beetles using fire. Prescribed fire has been successfully used to control cone beetles in red pine (Miller 1978) and in white pine seed orchards (Wade et al. 1989). Wade and others suggested that white pine cone beetles can be killed by a low intensity fire that scorches the cones and raises the internal temperature past a lethal threshold of 40-50°C.

Unfortunately, regular use of prescribed fire in a seed orchard has several drawbacks, including:

> 1) A short "window" in which to successfully conduct a burn. This is especially true in northern locations, such as in Wisconsin, where early spring fire danger ratings often go from very low to very high. At one extreme fuels are too wet to burn and at the other extreme, fuels and conditions make burning hazardous.

2) Annual prescribed fires can reduce fuel loads below what is needed for conducting a successful burn. Infested cones are scattered throughout an orchard and a rather "complete" burn is necessary for control.

Thus, what is needed is a technique that lengthens the burning window and provides complete heat coverage of the forest floor even when fuel loads are small or fuel is scattered.

This study investigated the use of a propane flamer mounted on a tractor as a means of applying intense heat to the forest floor in a seed orchard. Propane flamers have been used to successfully control insects and weeds in agricultural fields (Moyer 1992) and the technique and technology should transfer to seed orchard with minimal modifications.

Methods

A pre-assembled propane flamer unit (Thermal Weed Control Systems, Inc.) was used. The unit design consisted of 8 individual liquid burners. The burners and 100 gallon tank were mounted on a 3-point hitch. Burners were ca. 18 inches apart and were operated ca. 10 inches from the surface of the duff layer. The unit was equipped with an automatic ignition system.

The burner was field tested in spring, 1994, at the U.S. Forest Service, Oconto River Seed Orchard (ORSO), located on the Nicolet National Forest in northeastern Wisconsin. ORSO is not a single seed orchard, but, rather a complex of several seed orchards and breeding arboretums of different species. ORSO contains two blocks of eastern white pine, one 10 acre orchard and one 20 acre breeding arboretum. In both locations, trees are spaced ca. 20 ft x 20 ft apart. Trees are ca. 30 ft. tall. Terrain is flat, and both areas are mowed regularly and trees are pruned to a height of ca. 10 ft. The past two years, cone production has been heavy in both the orchard and arboretum. Populations of white pine cone beetles have been present in both areas.

Field trials conducted in 1994 consisted of two components, a series of plot trials and an operational trial.

<u>Plot trials</u>: Plots trials, made up of individual treatments, were conducted in the arboretum. Treatments consisted of the propane flamer unit operated at 3 or 4 different speeds, crawl, slow, medium and fast. These speeds were based on gear settings on the tractor. An untreated check treatment was included on each trial date. Each treatment was done on a plot that was 200 ft in length and 12 ft in width, the width of the flaming unit. All treatments were replicated six times between 6 April and 12 May, 1994.

Moisture content as percent oven dried weight of both cone beetle infested cones and fine fuels was recorded for the time and date of each trial. Fuel loading was calculated by collecting all

material in a ft^2, down to the soil layer. Five random ft^2 samples were collected. This material was weighed, a mean weight was calculated, and multiplied by 43,560 to obtain a per acre fuel load in tons/acre.

Following treatment, percent survival of cone beetles was calculated within each plot. A minimum of 25 cone beetle infested cones were collected from each plot, dissected and live and dead beetles recorded.

Operational trial: A simulation of an operational project was conducted in the 10 acre orchard on May 3 and 4. The propane flamer unit was operated at the medium speed. Fuel moisture content was recorded during the operation. Both pre- and post-burn cone samples were collected, 30 cones each, to compare percent beetle survival. Fuel use and time necessary to complete the project were documented.

Fuel loading was calculated by collecting all material in a ft^2, down to the soil layer. Five random ft^2 samples were collected. This material was weighed, a mean weight was calculated, and multiplied by 43,560 to obtain a per acre fuel load in tons/acre.

Results

Plot trials: The initial trials on 6 and 13, April, were conducted with extremely wet fuels (Table 1). Snow was still present under the orchard trees and on 6 April, the cones were still frozen on the inside. Air temperature during the 6 April treatments was 36° F. The propane flamer operated well. Fire behavior was minimal and in fact, snow melt did not even occur following burner application on the 6th. Beetle kill was minimal (Table 1).

The field trial conducted on 21 April, was conducted under very dry conditions and extreme fire hazard. Fuel moisture of cones was estimated at 13% (Table 1), and RH was 31%. All treatments with the flamer resulted in very active fire behavior, leaving a 30-100 ft hot fire behind the tractor. This resulted in beetle kill that appears quite good, 5-17% survival for all treatments, compared to 85% survival in the check block. The fire behavior probably equalized all treatments, since they all ignited, making any differention between treatments difficult. Application on 21, April, required active fire suppression and did not appear to differ greatly from a prescribed burn.

The field trial conducted on 3 May was done on the same day as the operational trial. Fuel moistrure was 17%. Fire behavior was much less intense than the previous trial because green-up had begun. Beetle survival was very erratic in the treatments. The crawl and slow speed treatments appeared to have provided good control, 6 and 12% survival, respectively (Table 1). However, the faster treatments actually had better survival than the check treatment.

Table 1. Results from plot trials conducted at the Oconto River Seed Orchard, Nicolet National forest, Wisconsin, in 1994.

DATE MONTH/DAY	% FUEL[1] MOISTURE	TREATMENT[2]	BURNER[3] ANGLE	% BEETLE SURVIVAL
4/6	195	Check	90	59
4/6	195	Slow	90	67
4/6	195	Medium	90	54
4/6	195	Fast	90	65
4/13	151	Check	90	67
4/13	151	Slow	90	45
4/13	151	Medium	90	18
4/13	151	Fast	90	40
4/21	13	Check	90	85
4/21	13	Crawl	90	11
4/21	13	Slow	90	7
4/21	13	Medium	90	17
4/21	13	Fast	90	5
5/3	17	Check	90	47
5/3	17	Crawl	90	6
5/3	17	Slow	90	12
5/3	17	Medium	90	50
5/3	17	Fast	90	68
5/5		Check	30	82
5/5		Crawl	30	22
5/5		Slow	30	62
5/5		Medium	30	55
5/5		Fast	30	66
5/12	24	Check	30	69
5/12	24	Crawl	30	37
5/12	24	Slow	30	31
5/12	24	Medium	30	39
5/12	24	Fast	30	41

[1]Moisture content as a percent of oven dried weight of cones killed in 1993 by cone beetles.

[2]Treatments consisted of an untreated check block, and blocks treated with the propane flamer unit pulled at 3 or 4 different speeds (crawl = 1st gear, slow = 2nd gear, medium = 3rd gear, fast = 4th gear).

[3]Angle that individual burner units were oriented in comparison to the ground (90° = burner directly towards the ground).

The trial conducted on 5 May was the first with the propane flamers modified to a 30° angle versus the 90° angle (straight up and down) used earlier. Fuel moisture was --. Cone beetle survival was again erratic over all treatments (Table 1), though survival over all treatments was less than the check block. The slowest treatment, crawl speed, did have only 22% survival.

The trial conducted on 12 May had a fuel moisture of 24%. All treatments showed a reduction in beetle survival (Table 1), though no treatment reduced survival below 30%. Fire behavior was noted as hot but easily suppressed. Green-up was well under way in the orchard.

These initial trials with the specific flamer we used brought out several points, including:

> Fine fuels and cones must be dry to obtain adequate control. This reduces the window available for treating orchards and increases the fire hazard. A specific minimum fuel moisture necessary for control has not been documented.
>
> Fire behavior becomes much more manageable once green-up begins.
>
> The lethal temperature for cone beetle control should be reexamined. The flamer appeared to apply intense heat and in addition caused ignition of most fuels, yet control in most cases was not extremely good.
>
> A number of adjustments on increasing pressures and burner angle should be done to attempt to improve killing efficiency of the flamer.

<u>Operational burn</u>: A perimeter burn was started at about 0830 on May 3. the intent was to burn a perimeter around the orchard to act as a fireline and then burn the middle of the orchard. Temperature was 50°F and 75% RH. After burning a short distance the burn terminated when it was noticed that several gas hoses had heat-checked. The flamer was then modified to eliminate the problem of excessive heat and flame rolling back toward the tractor and the hoses and wiring in that area. This was done by changing the angle of the burners from directly down (90°) to ca. 30° from horizontal. This aimed the heat and flame away from the tractor. In addition, a heat shield was constructed to further protect hoses and wiring for the electronic ignition.

At about 1530 the burn was restarted. Temperature was 70°F, humidity was ca. 40%. After the perimeter was burned, alternate rows were burned on a diagonal in a SE-NW direction. Fire ignition was terminated at 1930 and a fire watch was maintained until 2200. Burning was continued at 0900 on May 4. Conditions were much the same as the previous day. Burning was completed in all rows in a SE-NW direction. Then rows in a SW-NE direction were treated. This resulted in a very complete burn, at least 95

% of the orchard was blackened. Much of the orchard was exposed twice to the heat produced by the burner. The project was completed at 1600, though a fire watch was continued until 1900.

Moisture content of cones was 18%. Moisture content of needles (fine fuels) was 11%. Fuel loading was estimated at 5 tons/acre.

Approximately 245 gallons of propane was required to complete the 10 acre orchard. Propane costs approximately 60 cents/gallon. Therefore, cost of the propane was approximately 147 dollars. The orchard took ca. 11 hours to complete. On site during the burn was a group of approximately 7 people who were there to maintain the fire lines.

Beetle survival in cones prior to the treatment was 83 percent. Post-burn samples found 11 living beetles and 48 dead beetles (19 % survival).

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Sandy Kegley, R-1
Jed Dewey, R-1

1993-1994 REGION 1 ACTIVITIES FOR MANAGEMENT OF SEED, CONE, AND REGENERATION INSECTS

Sandy Kegley and Jed Dewey

Region 1 has several orchards that have been or are just starting to produce cones with more tree improvement areas (TIA) to be converted into seed orchards in the future. We also have many tree improvement plantations of various ages and tree species. The current cone producing orchards by species are:

Rust resistant western white pine	Douglas-fir	Ponderosa pine
Coeur d'Alene nursery	Dry Creek	Russell Bar
Lone Mountain		
Grouse Creek		
Priest River		

Our 1993-1994 activities in the TIA's, other plantations, and seed orchards include the following:

Lenore TIA

The Lenore TIA is a 4 year old ponderosa pine plantation. It was established in 1990 to test growth characteristics of improved stock from throughout the region. Since it is an early selection growth trial, all insects and diseases affecting growth need to be controlled. Since the plantation was established, damage caused by the ponderosa pine tip moth, *Rhyacionia zozana*, has occurred on terminal and lateral shoots. Terminal buds are destroyed, greatly affecting growth. Chris Niwa provided pheromones and we trapped moths to help with the timing of control methods. In the spring of 1993, the plantation was sprayed with carbaryl a week after the first moths were caught. A second application occured 2 weeks later. Damage decreased from 10% of terminals destroyed before treatment to 1.5% after. However, the spray was aimed mainly at the terminals and a large number of laterals remained infested.

In 1994, we tried a mating disruption technique. Working with Chris Niwa, we obtained *R. zozana* pheromone and had it impregnated into plastic strips. These were placed throughout the plantation before moth flight. Results are pending.

Tip moths in Southeastern Montana

Through the use of pheromone baited traps, we have discovered a guild of at least 4 and possibly 5 species of *Rhyacionia* infesting ponderosa pine regeneration in southeastern Montana. *R. fumosana*, *R. bushnelli*, and *R. neomexicana* have been positively identified and *R. zozana* and/or *R. busckana* were also trapped in the area.

Carol Bell has established permanent plots on the Ashland Ranger District, Custer National Forest, to evaluate the effect of thinning on tree height growth and stem deformity which may be affected by tip moths. Plots have been ced in thinned and adjacent unthinned (control) stands of 10 to 15 year old .nderosa pine regeneration.

Terminal Weevil Survey

Over the past few years, we have conducted surveys of lodgepole pine plantations to determine the incidence and severity of terminal weevil (Pissodes terminalis) damage. We sampled stands of a variety of ages, densities, elevations, and aspects to determine site characteristics conducive to terminal weevil damage. The survey is on going.

Shoot Borer Control at Condon

The ponderosa pine plantation at Condon has been treated for the past several years using luretape for mating disruption of Eucosma sonomana. This year was the final year of treatment. Results have been very good. However, Luretape will no longer be available commercially.

Big Fork TIA

The Big Fork TIA was coverted from a farm field to a plantation. They have had a problem with white grubs feeding on planted tree seedlings. The area is pected annually and treated periodically with diazinon.

Routine Seed Orchard Surveys

All our seed orchards are visited on a monthly basis to determine the general health of the orchards as well as cone and seed insect problems. Our major pest problems occur in the western white pine orchards and include Leptoglossus occidentalis, Dioryctria abietivorella, and Conophthorus ponderosae. Monitoring methods continue to be limited to direct observation.

Treatments for L. occidentalis with the insecticide Pounce occur on an annual basis at the Coeur d'Alene western white pine seed orchard. We also sprayed Pounce aimed at L. occidentalis control for the first time at the ponderosa pine seed orchard at Russell Bar.

Arboreal sprinklers for single-tree treatment

In cooperation with Jack Stein, PSW, Jack Barry, Pesticide Application Technology, and Diane Hertzberg, MTDC, R-1 installed 10 individual sprinklers in the tops of western white pine trees in the Coeur d'Alene nursery orchard. Damage from L. occidentalis will be compared between the individual tree sprinklers, regular hydralic spray from the ground, and unsprayed controls.

Cone and Seed Insects of Whitebark Pine

Because of the decline of whitebark pine due to blister rust and mountain 'e beetle, and its importance as food for wildlife and high elevation -hetics and watershed values, there is a high demand for whitebark pine seed and seedlings for regeneration purposes. To date, virtually nothing is known of the insects affecting regeneration of whitebark pine. Region 1 has initiated a study to identify the insects affecting cones, seeds, and regeneration. So far this spring, we have been visiting sites to determine the size of the cone crop for later cone collections. The cone crop this year is not good. Many sites don't have any cones at all. Last year's abnormally cool and wet summer probably contributed to the poor cone crop. However, we have identified a couple sites so far with sufficient numbers of cones to collect and rear. The objective for this year is to obtain some baseline data of species and abundance of insects affecting whitebark pine and to identify sites with cones for next year. In future years, we hope to determine impact of the insects we find and eventually management strategies.

Regeneration issue
an example of
relationship
between [illegible]
[illegible]

On the Trail of the Whitebark Pine

If you've hiked the high country in northwestern Montana this summer, perhaps you've noticed the skeletons of dead or dying trees along the trail. Many of these skeletons are dead whitebark pine. The Glacier View Ranger District has initiated a project to learn more about whitebark pine and its ecosystem in the North Fork area.

Whitebark pine is a major component of high elevation forests in northwestern Montana, especially on dry, exposed ridgelines and south-facing slopes. They have died or are dying from two major causes: infestations of mountain pine beetle in the '70s and '80s and white pine blister rust (a fungus), which has been chronic here for decades.

High mortality in whitebark pine has alarmed forest and wildlife biologists for several reasons. One is a simple respect for maintaining species that have historically occurred in our forests for biological reasons—some of which may yet be unknown. For example, all species of trees are useful at high elevations for retaining snowpack and preventing avalanches. Whitebark pine acts as a "nurse tree" at high elevations, offering relief from harsh conditions that enables subalpine fir and spruce to grow near it. Without whitebark pine in the ecosystem, other tree species may not be able to grow as far upslope.

Another reason for concern about whitebark pine mortality is that this species has historically been an important bear food. Whitebark pine seeds have a high digestible fat content and may even contain estrogenic compounds that favorably affect bear reproduction. The seeds conveniently ripen in late summer when bears are foraging intensely to prepare for a winter in their dens. However, bears in northwestern Montana have had virtually no whitebark pine seeds to eat for a decade or so.

How can we restore the whitebark pine forests of northwest Montana? In nature, whitebark pine relies on a bird—the Clark's nutcracker—to plant its seeds. As a fascinating example of co-evolution, the nutcracker pries apart closed whitebark cones to extract the seeds. It collects up to 100 seeds in its gullet before flying as far as 14 miles away to cache the seeds. The birds seem to favor cleared, exposed sites. They fly down to the ground and bury the seeds about one inch deep, exactly the right depth for germination. During the following spring, the birds fly back to these caches and retrieve the seeds for food. However, they don't get them all, and some germinate.

Research biologists are convinced that fire suppression during this century has reduced the habitat available for whitebark pine regeneration. Prescribed fire may be the answer to preparing some high-elevation sites specifically to encourage the Clark's nutcracker to bury seeds there. Also, genetic research is being conducted to produce seedlings resistant to white pine blister rust that may one day be planted on suitable sites.

This summer, the Whitebark Pine Team of Glacier View Ranger District initiated an intensive study of whitebark pine and its high-elevation ecosystem in the North Fork Flathead River drainage. They have begun to collect data from an array of sample plots located throughout the high country. The study will answer some immediate questions about the present distribution and health of whitebark pine in the North Fork, as well as how the situation has changed in the last few decades. From this information, the team will better be able to pinpoint where management opportunities—such as prescribed fire—should be initiated. If you have noticed a change in the distribution of whitebark pine in the North Fork or want more information, contact the team at the Glacier View Ranger District, P.O. Box W, Columbia Falls, MT 59912 or call (406) 892-4372.

by Sally Murdock, Writer/Editor
Glacier View Ranger District,
Flathead National Forest
1993

Walking on the Wild Side

"Entertaining!" "Involved us all." "Very Informative." "Makes learning fun!"—written feedback from "Walk on the Wild Side" audiences.

It is entertaining to watch friends and co-workers play rocks, trees and animals in a wilderness skit. Everyone is involved with the education effort, from wilderness staff and frontliners to community partners. Not only do audiences learn something about wilderness, but presenters are also becoming more informed—learning to be teachers! Learning is fun with stories of hidden leave-no-trace gold and the use of props like the wilderness values box.

Through the dedicated efforts of employees and community partners, September marked the second successful year for the Bob Marshall Wilderness Complex (BMWC) Education Program. In 1992, the BMWC developed and began implementing a coordinated education strategy to direct the wilderness education efforts, a challenging task in that the Bob Marshall stretches over five ranger districts in four national forests—the Flathead, Helena, Lewis and Clark and Lolo.

In the last two years, over 4,000 people—including campground visitors, scouts, other youth groups, school students, teachers, fair visitors, forest and wilderness visitors, plus Forest Service employees—took a "walk on the wild side," learning about wilderness and ways to protect this special 1.5 million-acre resource. Besides formal presentations, education messages were presented through news articles, local publications, radio announcements, trailhead and office bulletin boards, trailhead and field contacts, demonstration camps, plus the popular 16-station skills trail. It has been a full two years and we look forward to next year's opportunities! Hats off to the energetic, enthusiastic and committed employees who have contributed to a successful education program!

Teresa Wenum demonstrates to some elementary school youngsters how horses should be tethered in the wilderness, using "Stella" the wilderness horse as a teaching aid

by Teresa Wenum.
Bob Marshall Wilderness Education Coordinat
Hungry Horse Ranger District, Flathead National Fores.

Rendezvous for Wilderness Rangers Held at Birch Creek

by Douglas Schnitzspahn,
Volunteer, Student Conservation Association
Dillon Ranger District, Beaverhead National Forest

The intricacies of managing wilderness, or in some cases conscious non-management, seem to be growing as public demand for wild lands increases. The different approaches to management and other concerns were discussed at the annual Wilderness Ranger Rendezvous at the Birch Creek Outdoor Education Center, Beaverhead National Forest, August 23-27.

Over 70 permanent and seasonal employees gathered at the end of the summer season celebration to interact, talk over wilderness issues, and brush up on wilderness skills. While most attendees were from the Northern Region, the event also attracted wilderness rangers from Regions 4, 5, and 8. Speakers included Regional Forester Dave Jolly, Congressional staffer Jim Bradley, and Fred Matt, wilderness manager for the Salish Kootenai Tribe.

The rendezvous was organized by R-l Wilderness Excellence Team, with Judith Fraser, coordinator for the Anaconda Pintler Wilderness, taking the lead. The event was followed by a wilderness restoration workshop conducted by Joe Flood, wilderness ranger, Mission Mountains Wilderness.

Seasonal wilderness rangers and other R-1 wilderness staff trying out childrens game, "Circle of Life," showing how every part of the environment is interconnected. A circle is formed, each person sitting on the knees of the next. If anyone tries to stand, the circle is broken. At far right is Herb Spradlin, West Fork Ranger District forest wilderness manager. To his immediate right is Connie Meyers, director, Arthur Carhart National Wilderness Training Center.

Nancy Rappaport, PSW/FIDR

1993 4 REPORT: SEED, CONE, AND REGENERATION INSECTS STEERING COMMITTEE

Nancy Rappaport, PSW Research Station, Albany, CA

Current Research:

1. Stereochemistry of western cone beetle behavioral chemicals (Rappaport, Seybold, Francke and Page).

2. Impact of cone and seed insects on sugar pine seed production at Badger Hill Clone Bank (Rappaport, Samman, and Stover).

3. Impact of cone and seed insects on sugar pine seed production at Foresthill Seed Orchard (Rappaport, Trummer, and Binder).

4. Impact and control of Port-Orford-Cedar cone and seed insects (Rappaport, Sandquist, and Greenup).

5. Athropod-induced abortion of first-year sugar pine cones (Rappaport, Sniezko, Danielson, Kitzmiller, Samman, and Stover).

6. Mechanisms of megagametophyte induction in Douglas-fir by Megastigmus spermotrophus (Rappaport and DuMas).

7. Megastigmus albifrons in ponderosa pine: potential for development of larvae in unfertilized seed (Rappaport and Stein).

8. Arboreal sprinklers for single-tree treatment against cone and seed insect attack (Rappaport, Barry, Herzber, Stein, and Catchpole).

T. D. Schowalter, OSU

Annual Report to
National Steering Committee on Management of Cone, Seed and Regeneration Insects

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This annual report describes a cooperative effort with Roger Sandquist, Bill Randall and Pete Owston (U.S. Forest Serv.) to evaluate the effectiveness of litter flaming as a means of controlling Douglas-fir cone gall midge, *Contarinia oregonensis* Foot, and Douglas-fir seed chalcid, *Megastigmus spermotrophus* Wachtl, in seed orchards. These insects are the two most destructive species associated with reduced seed yields in Douglas-fir seed orchards in western Oregon. Because of their cryptic habits, few non-chemical tactics for controlling populations of these species are available. However, their habit of overwintering in litter under host trees makes them vulnerable to litter treatment such as burning.

Initial assays in the lab indicated that midge larval mortality increased as temperature and duration of heat exposure increased and was maximized under dry conditions. Subsequent efforts to achieve these lethal temperatures at the Beaver Creek Seed Orchard during winter and spring 1993-94 were unsuccessful. Wet litter conditions prevented burning during much of the period, and flaming trials achieved maximum surface temperatures of up to 200° C but temperatures at the soil surface under litter were unchanged (Figs. 1-3). We modified our experimental plan by adding a preliminary step to pulverize and dry the litter using a standard flail chopper, but wet conditions continued to prevent heat penetration below the litter surface. Our plan for next year calls for litter treatment in fall to minimize available habitat for midge larvae.

Publications

Schowalter, T.D. 1994. Cone and seed insect phenology in a Douglas-fir seed orchard during three years in western Oregon. J. Econ. Entomol. 87: 758-765.

Schowalter, T.D. and G.M. Filip, eds. 1993. Beetle-Pathogen Interactions in Conifer Forests. Academic Press, London. 252 pp. (addresses regeneration)

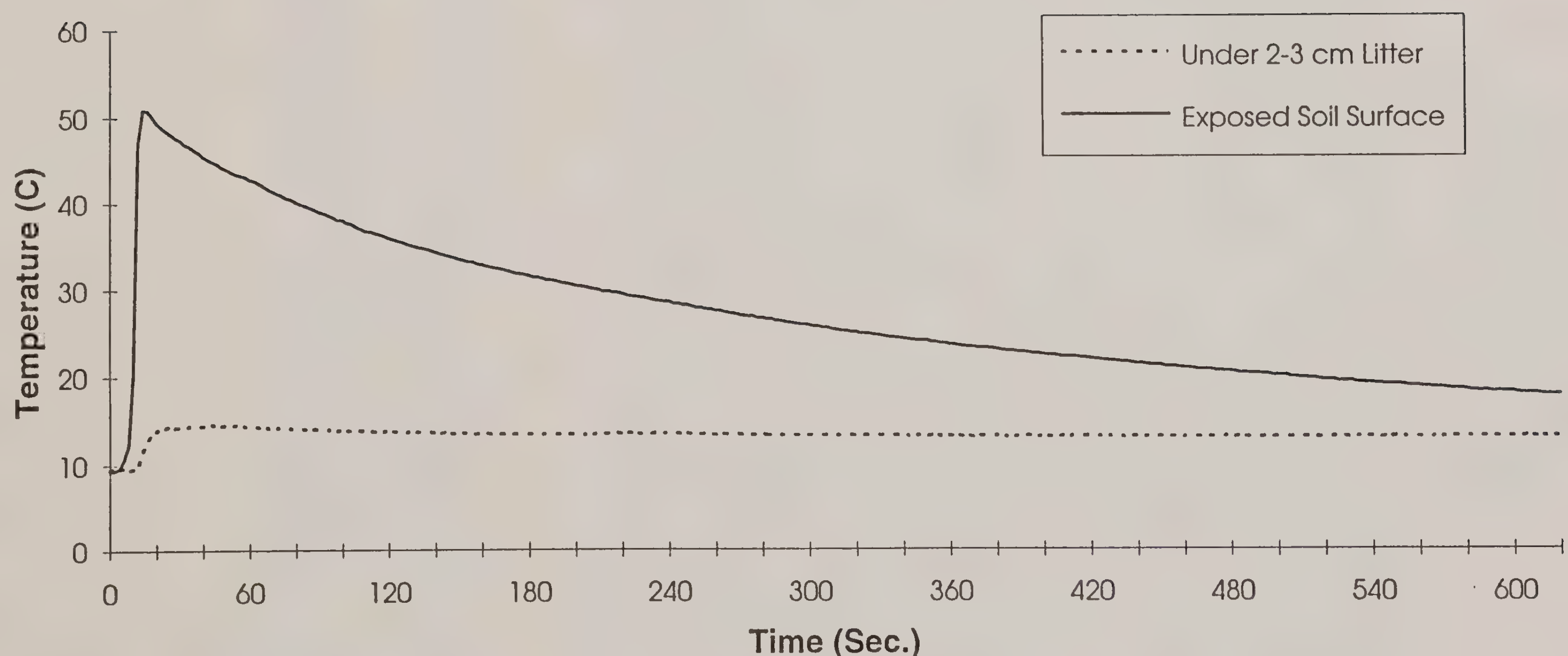

Figure 1. Temperature profile from flaming unchopped litter at Beaver Creek Seed Orchard during January 1994

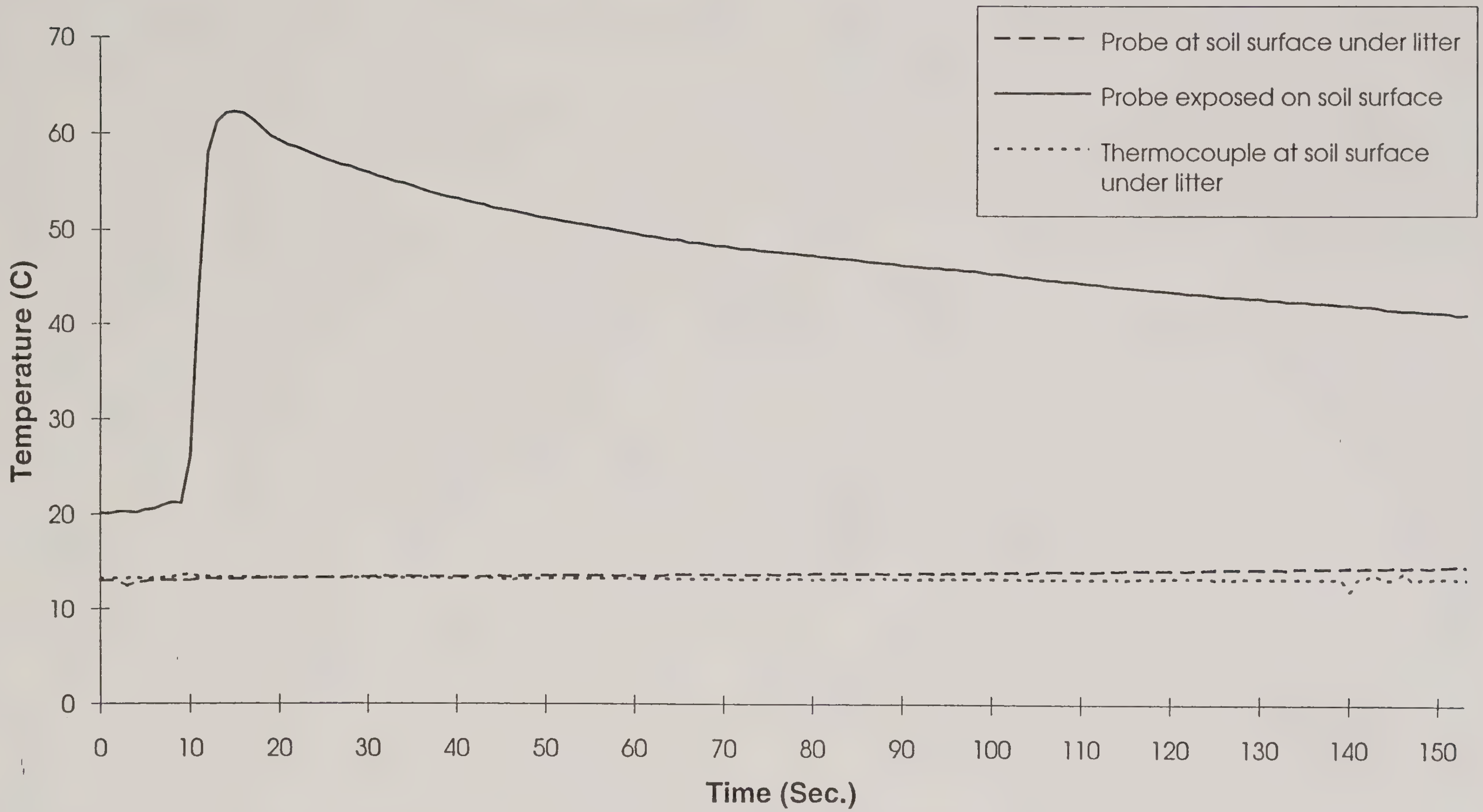

Figure 2. Temperature Profile from flaming unchopped grass at Beaver Creek Seed Orchard in April 1994

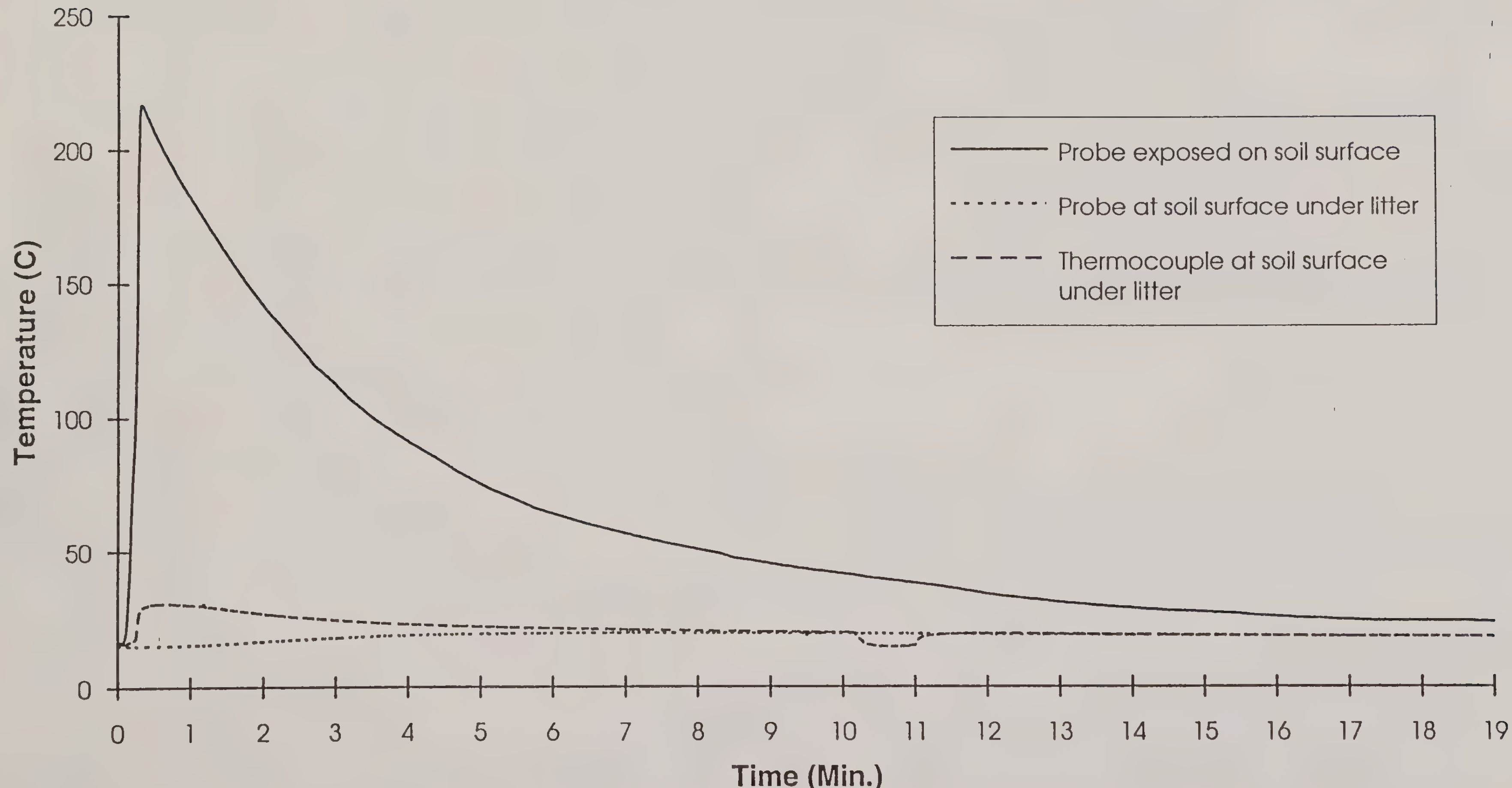

Figure 3. Temperature profile from flaming chopped grass at Beaver Creek Seed Orchard in April 1994

Appendix C

Committee Technical Development
Recommendations 1994

United States Department of Agriculture
Forest Service
Washington Office
2121 C Second Street
Davis, CA 95616
PH (916)551-1715
FAX (916)757-8383

Reply To: 3400

Date: July 18, 1994

Subject: Technology Development Needs - Seed, Cone, and Regeneration Insects

To: Mel Weiss, Acting Director, FPM

The National Steering Committee for Managing Seed, Cone, and Regeneration Insects met in Rhinelander, WI, June 28-30, 1994 and identified several technology development needs. The committee ranked each need equally and noted those of national importance to state, federal, and private land managers. The technology development needs submitted by the committee are listed:

- Develop a risk-rating system for western pineshoot borer in lodgepole pine and ponderosa pine.
- Perform exclusion assays to determine insect role in conelet abortion and seed yield in white bark pine and western white pine.
- Demonstrate and transfer IPM technology for seed bugs and coneworm. Included is a degree-day evaluation for seed bugs.
- Further single tree spray system by evaluating reduction of volume, increasing tree coverage, and improving efficacy of application. Transfer technology including applications in urban forestry.
- Evaluate Asana XL in northern red oak orchards to control flower and acorn insects.
- Conduct pilot tests of synthetic nicotines, (Admire, Merit, and Gaucho), in seed orchards.
- Develop non-chemical alternatives to control Douglas-fir cone gall midge and white-pine cone beetle.
- Demonstrate and evaluate the "trap-out" potential of pheromone-based mass-trapping of cone beetles in eastern white pine and seed orchards.

/s/John W. Barry
JOHN W. BARRY
Chair

cc: Members, Steering Committee

Appendix D

Chuck Masters, et al. White Paper

The Role of the Forest Service in Seed Orchard Pest Management Research

A Position Paper of the
Southern Forest Tree Improvement Committee

February 20, 1995

The Role of the Forest Service in Seed Orchard Pest Management Research

A Position Paper of the Southern Forest Tree Improvement Committee

Introduction

The Southern Forest Tree Improvement Committee (SFTIC) represents the community of forest geneticists and tree breeders in the southern US, including three southern forest tree improvement cooperatives with a combined membership of 47 industrial organizations and state agencies across the 12 southern states. SFTIC organized the Seed Orchard Pest Management Subcommittee (SOPMS) in 1989, to coordinate region-wide research and development in orchard pest management. The SOPMS also has members representing state agencies and private industry in the western US.

This paper presents our views on how the Forest Service should be involved in research, technology development, and technology transfer in seed orchard pest management. We will discuss the following topics:

- the diminishing federal contribution to timber supply in the US,
- the need to increase productivity of state and private forest lands,
- the value and on-going nature of tree improvement programs,
- the role of seed orchards and seed orchard pest management in the production of genetically improved material,
- the responsibility of the Forest Service to provide leadership for the Nation's forestry community,
- the historic role of the Forest Service in seed orchard pest management research, and
- the research needed today in the area of seed orchard pest management.

In summary, it is our opinion that it is important to the Nation that the Forest Service continue its historically strong support of seed orchard pest management research.

Timber Supply: The Productivity Challenge

In recent years, changing public opinion regarding the function of federally owned forest lands has led to significant reductions in timber offered for sale by the Forest Service. Timber offered for sale has declined for three consecutive years, with the amount offered in 1993 (4.6 billion board feet) less than half the amount offered in 1990 (12 billion board feet). If current levels are maintained, or continue to decline, the amounts will be well less than half the amounts recommended in the 1990 Resources Planning Act for the years 1995 through 2040[1]. The decreased harvest has had a heavy impact on Western states; for example, in the state of Oregon, federal timber contributed 3-4 billion board feet per year to the annual harvest from 1983 to 1987, but based on current timber sales, the federal contribution has dropped to about 400 million board feet per year[2]. **The reduction of timber harvests on federal lands has placed increased demands on private forest lands (both in the west and the south) to be more productive.** The pressure to be more productive on less land will increase even more in the future if state governments withdraw lands from timber production, or adopt stringent regulations on forest management. If the demand for wood is not met domestically, the US will need to rely increasingly on imports, possibly increasing pressure to exploit world forests that are less well managed and more environmentally sensitive than ours. If private forest lands in the US are to make up the difference, genetic gains from tree improvement programs will be crucial. However, these genetic gains can only be realized if there is effective pest protection in the seed orchards where genetically improved seed is produced.

It is evident that federally-owned forest lands are being withdrawn from timber production in favor of other natural resource goods and services. **It is our opinion, that in response to this situation, the role of the Forest Service in production-oriented research and technology development should not be decreased, but actually be increased.** Additional efforts by the Forest Service to improve productivity on state and private lands dedicated to timber production will aid in accomplishing one of its mandated goals of keeping our Nation's forest lands fully productive. In particular, we recommend strong support of Forest Service programs focused on management of seed orchard pests.

Tree Improvement and the Importance of Seed Orchards

The science of tree improvement is relatively young, however it has had significant impact on the forest industry. For many species, both in the United States and around the world, tree improvement became an important aspect of forestry in the 1950s. Increasingly, any type of afforestation or reforestation effort relies on genetically improved stock. For example, in the southern US, over 90% of pine plantations are established with improved material.

Genetic improvement of any crop, including trees, relies on *selection* from a base population, *genetic testing* of the selections to confirm their superiority, and *breeding* to generate a new base population; this is then followed by another cycle of selection, testing and breeding. Thus, genetic improvement is a continuous process, with better material available after each cycle. Most tree improvement programs began with mass selection (identification of superior phenotypes) in native stands or plantations, followed by grafting of these selections into production seed orchards. After genetic testing, seed orchards were rogued or thinned, and clones proven to be poor performers were removed. The genetic gains achieved in most operational tree improvement programs have been substantial; for example, for growth traits, gains are on the order of 7 to 15% from mass selection, and 10 to 20% following roguing. Additional genetic gains have been made in other traits: stem form, wood quality and disease resistance. New advanced-generation orchards (established after additional testing, breeding and selection) are either currently producing or will be producing seed by the year 2005; these orchards will yield even higher genetic gains.

The economic value of these levels of genetic gain applied across the thousands of acres regenerated each year is truly staggering, with NPV of additional wood production due to genetic improvement equal to tens and perhaps hundreds of millions of dollars every year[3]. Realization of this value depends on the production of genetically improved seed for reforestation; this is the function of the seed orchard. Various cone and seed insects can devastate an orchard seed crop, thus, most organizations control insects through aerial spraying of chemical insecticides. **Without a comprehensive insect control program, losses of 50% of the orchard crop are common, and losses of 90% have been documented.** The information and technology needed for the effective control programs currently in use were developed through the combined efforts of forest industry, state forestry agencies and Forest Service scientists. Acreages of advanced-generation orchards (producing seed of the highest genetic quality) have been established assuming that effective insect control programs will be in place.

Today, however, there is growing concern among the public, and consequently governmental agencies over various environmental issues. For example, the Environmental Protection Agency (EPA) is searching for opportunities to curtail or minimize pesticide usage, hence we may lose registration of some of the most effective chemicals currently used in operational orchards. Current federal requirements make it extremely difficult to obtain (or even maintain) pesticide registrations, and thus it often requires a coalition of interested parties to provide the necessary research data. In addition, there is increasing

desire for more than just efficacy in our insect control programs. The desire is for safer and more environmentally-friendly insect control programs that will still provide the level of control needed to protect valuable seed orchard crops. These programs may include new insecticides, reduced rates of current insecticides, and some type of biological control, all combined into an integrated pest management strategy. We believe that the Forest Service should play an important role in the critical research and development necessary to design and implement these new control programs.

The Mission of the Forest Service

It is the responsibility of the USDA Forest Service to provide overall leadership in forest and forest-range conservation, development and use. This includes the development of policies and programs needed to keep the Nation's private and public lands fully productive[4]. Our forests produce an array of natural resources, including recreation, water, wilderness, wildlife, and wood. The needs of the Nation for these natural resources, particularly wood, cannot be accomplished only on federally-owned forest lands. In fact, Congress has found that

> *"most of the productive forest land of the United States is in private, State, and local governmental ownership, and the capacity of the United States to produce renewable forest resources is significantly dependent on such lands".*[5]

As regards forest pests, Congress found that

> *"insects and diseases affecting trees occur and sometimes create emergency conditions on all land, whether Federal or non-Federal, and efforts to prevent and control such insects and diseases often require coordinated action by both Federal and non-Federal land managers".*[6]

The interaction between the Forest Service and non-federal forest land managers is primarily the responsibility of State and Private Forestry, and protection from insect and disease is the responsibility of Forest Health. One of the activities proscribed by Congress for Forest Health is to

> *"determine the biological, chemical, and mechanical measures necessary to prevent, retard, control, or suppress incipient, potential, threatening, or emergency insect infestations and disease conditions affecting trees".*[7]

One objective of the Forest Service mission is *developing and providing scientific and technical knowledge improving our capability to protect, manage and use forests and rangelands.*[8] In the past, this objective has been admirably achieved in the area of seed orchard pest management. Forest Service entomologists have played a major role in determining the biology, life cycle and control of cone and seed insects, particularly in the South. Important basic and applied results have been determined by Forest Health and the Forest Experiment Stations through cooperative studies involving universities, state forestry agencies and forest industry. For example, Forest Service personnel and funds have been instrumental in the following critical areas:

- evaluating monitoring techniques for assessing insect populations and damage,
- developing techniques for aerial application of insecticides in seed orchards,
- designing and conducting field tests of promising insecticides (e.g., carbofuran, azinphosmethyl, fenvalerate, esfenvalerate, malathion, acephate, and bifenthrin),
- conducting field tests of the biological control organism *Bacillus thuringiensis* (Bt),
- developing and evaluating the Southwide Coneworm Pheromone Monitoring System,
- designing and implementing strategies for mating disruption of the webbing coneworm, and
- designing and conducting research to fill data gaps in order to maintain registration of several important seed orchard insecticides.

The past cooperation between Forest Service scientists and their state and private clientele in the area of seed orchard pest management is a tremendous success story. The current needs in this area are more pressing and the necessary research more complex than in the past, thus every effort should be made to ensure that this fruitful association continues in the future.

Research Needs in Seed Orchard Pest Management

The need for increased timber productivity on less land, along with increased pressure to modify the current patterns of pesticide usage make this a critical time for forestry and forest tree improvement. In the area of seed orchard pest management, a substantial research and technology development effort is essential. **Historically, the Forest Service has provided leadership in this research area. We believe it is critical that the Forest Service continues to do so in the future.** Private industry is very willing to cooperate with Forest Service scientists in conducting necessary projects to develop and implement orchard pest management programs, and can contribute substantial "in-kind" support: labor, land, money for application of experimental control programs in their orchards, experimental measurements, etc. However, the expertise of Forest Service specialists has been crucial in the past, and will continue to be extremely important in the future if long-term production requirements are to be met.

The SOPMS developed a survey in March 1994 to prioritize a number of research topics. The survey was distributed primarily to orchard managers in both the southern and the western US. For the southern states (VA, TN, NC, SC, GA, FL, AL, MS, LA, AR, OK, TX), surveys were distributed to both state agencies and private industries; for the western states (OR, WA, CA, ID, MT), surveys also went to various National Forests. Respondents were asked to rank six subject areas in order of priority:

- **Insect Biology**
  to gain a better understanding of life cycles, migration patterns, and other aspects of insect biology to enhance control and Integrated Pest Management strategies.
- **Alternative Insecticides**
  to examine efficacy of new insecticides, focusing on "environmentally friendly" products.
- **Evaluation of Current Insecticides**
  to test options of reducing amount of current products applied by a) extending application intervals, b) reduction of application rates, c) improving application techniques.
- **Population Monitoring**
  to develop reliable techniques of identifying optimum time of insecticide treatment.
- **Pheromone Development**
  to identify important reproductive pheromones and refine techniques such as mating disruption to control insect populations.
- **Biological Control**
  to investigate natural enemies of cone and seed insects, and effects of insecticides and cultural practices on these enemies.

A total of 77 responses were received (36 in the south, 41 in the west). The results of the survey are summarized for the two regions in Figure 1. In both regions the development of **Alternative Insecticides** was highly ranked (1st in the south, a close 2nd in the west). This may reflect a widespread perception of imminent loss of registration of current insecticides. Without alternative products, such a loss would be a severe blow to our efforts to increase productivity through genetic improvement. **Insect Biology** was ranked 1st in the west, perhaps reflecting the need for basic information on a wider range of tree species and their insect pests in the west as opposed to the south.

Conclusions

The Forest Service has a legislative mandate to provide leadership in keeping the Nation's public and private forest lands fully productive. The demand for wood products in the US will continue to grow, and the decreased harvest of wood from federal lands means that there is increased pressure on state and private lands to be more productive. We believe that the Forest Service has a responsibility *to develop and provide the scientific and technical knowledge* to make this increased productivity possible. Tree improvement can play an important role in increasing the productivity of state and private lands dedicated to timber production. Forest Service scientists are needed to ensure that the genetically improved material for reforestation can be efficiently produced. Seed orchard pest management is economically and environmentally important, and should receive strong support.

Endnotes

[1]Highlights, Report of the Forest Service, Fiscal Year 1993. 1994. USDA Forest Service, Washington DC.

[2]Gary Lettman, Forest Economist, Oregon Department of Forestry, personal communication.

[3]To illustrate, consider the following information for the South US, where approximately 1 million acres per year are established in pine plantation. Assume 1.5 cords/acre/year, a 25 year rotation, $40/cord stumpage value, 15% genetic gain, and a real interest rate of 5%. Then the NPV of additional wood due to genetic improvement from one years harvest equals $66 million. Since genetic gain is permanent, this marginal gain can be realized every year, as long as improved material is planted.

[4]Code of Federal Regulations, Title 36. 1994.

[5]Forest Stewardship Act of 1990.

[6]Ibid.

[7]Ibid.

[8]US Government Manual. 1994.

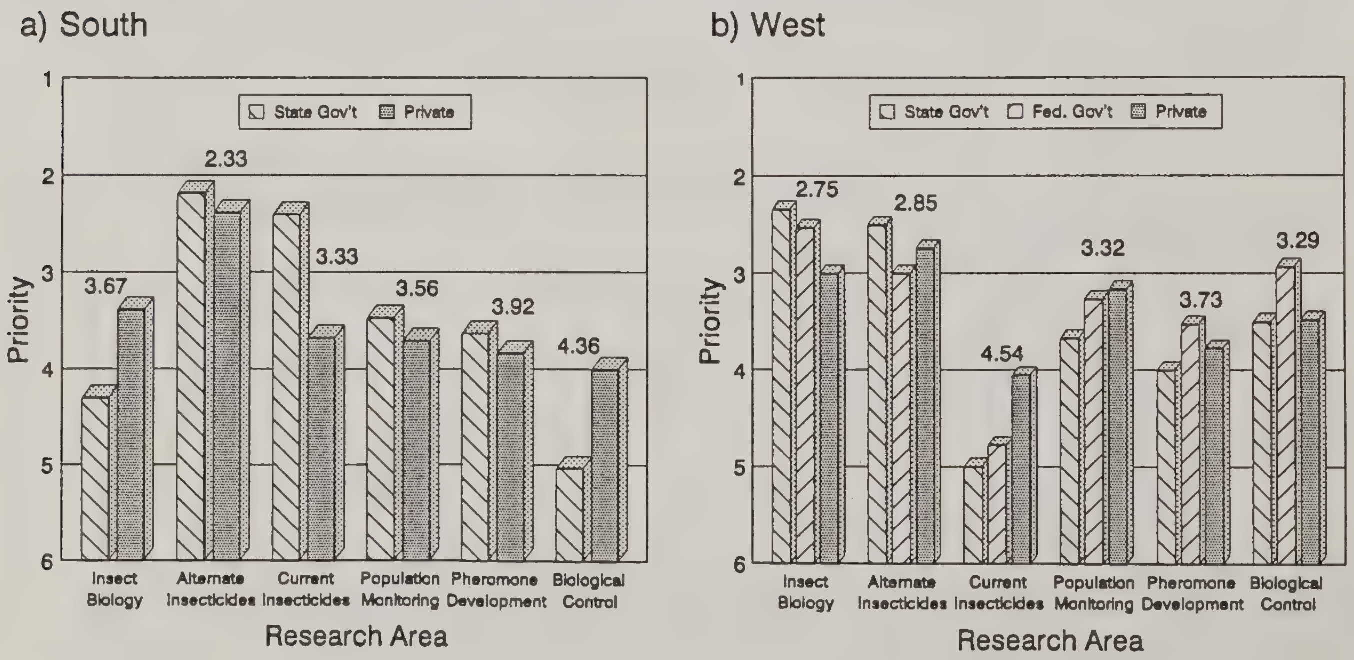

Figure 1. Average priority assigned to research areas in seed orchard pest management for the southern (1a) and western (1b) United States. Survey respondents were primarily seed orchard managers. Number of respondents was 87 (SOUTH: State=12, Private=24; WEST: State=6, Federal=14, Private=21).

NSC - SEED, CONE, AND REGENERATION INSECTS
SOPMS "WHITE PAPER"

- THE SOUTHERN SEED ORCHARD PEST MANAGEMENT SUBCOMMITTEE (SOPMS) OF THE SOUTHERN FOREST TREE IMPROVEMENT COMMITTEE REPRESENTS 3 SOUTHERN FOREST TREE IMPROVEMENT COOPERATIVES WITH A COMBINED MEMBERSHIP OF 47 STATE AND INDUSTRIAL ORGANIZATIONS ACROSS TWELVE SOUTHERN STATES.

- THE ROLE OF SOPMS IS TO DIRECT RESEARCH AND DEVELOPMENT IN THE AREA OF SEED ORCHARD PEST MANAGEMENT TO INSURE A CONTINUING SUPPLY OF GENETICALLY IMPROVED SEED FOR REFORESTATION. CRITICAL TO THE SUCCESS OF THIS EFFORT IS THE CONTINUED COOPERATION OF INDUSTRY AND STATE ORGANIZATIONS, AND THE CONTINUED SUPPORT OF US FOREST SERVICE SCIENTISTS.

- THE IMPORTANCE OF THIS EFFORT IS REALIZED WHEN CONSIDERING THAT:

    1. MILLION ACRES OF TIMBERLAND IN THE SOUTH PRODUCE ABOUT TWO-THIRDS OF THE DOMESTIC ROUNDWOOD USED FOR PULP AND PAPER, ONE-THIRD OF THE TIMBER FOR LUMBER, AND ABOUT TWO-FIFTHS OF THE TIMBER FOR VENEER AND PLYWOOD. IN THE WEST, DOUGLAS-FIR ACCOUNTS FOR 25% OF THE TOTAL SOFTWOOD HARVEST IN THE U.S.

    2. THESE ORGANIZATIONS INTENSIVELY MANAGE ABOUT 10,000 ACRES OF SEED ORCHARDS (WEST - 3,288 AC.) , AND IN 1987, PRODUCED THE SEED TO GROW 1.3 BILLION SEEDLINGS, WHICH WERE USED TO REFOREST 1.8 MILLION ACRES OF LAND. THIS REPRESENTED 85% OF ALL REFORESTATION EFFORTS IN THE SOUTH WITH A PRESENT VALUE OF $43.5 MILLION.

NSC - SEED, CONE, AND REGENERATION INSECTS
SOPMS "WHITE PAPER" -- cont'd

3. INSECT CONTROL PROGRAMS ARE A NECESSITY SINCE THEY CAN EASILY DESTROY OVER 50% OF A SEED CROP, AND LOSSES OF 90% HAVE BEEN DOCUMENTED.

- THE CONCERN THIS SUBCOMMITTEE HAS IS:

  REDUCED EMPHASIS IN TIMBER MANAGEMENT BY THE US FOREST SERVICE AND THE BLM IS RESULTING IN LESS FUNDING TO SUPPORT SEED ORCHARD PEST MANAGEMENT EFFORTS.

  INCREASED TIMBER PRODUCTION ON A SHRINKING LAND BASE WILL BE REQUIRED, WHICH EMPHASIZES THE NEED TO NOT ONLY MINIMIZE THE LOSS OF GENETICALLY IMPROVED SEED FROM SEED ORCHARDS, BUT TO IMPROVE YIELDS.

  GIVEN THE DESIRE OF THE PUBLIC AND THE EPA TO CURTAIL/MINIMIZE THE USE OF PESTICIDES, WORK ON INTEGRATED PEST MANAGEMENT SYSTEMS IS URGENTLY NEEDED.

- THE WHITE PAPER, A WEST/SOUTH EFFORT, WILL DISCUSS THE VALUE OF SEED ORCHARDS AND HOPEFULLY SENSITIZE APPROPRIATE US FOREST SERVICE AND STATE ADMINISTRATORS TO THE NEED FOR CONTINUED SUPPORT OF BOTH RESEARCH AND TECHNOLOGY PROJECTS DEALING WITH SEED ORCHARD PEST MANAGEMENT.

NSC - SEED, CONE, AND REGENERATION INSECTS

DISCUSSION ON GOAL SELECTION PROCESS

- SEVERAL COMMITTEE MEMBERS REPRESENTING THE NORTHWEST MET TO DISCUSS CONCERNS ABOUT THE GOAL SELECTION PROCESS AND TO REACH CONCENSUS ON RESEARCH AND TECHNOLOGY DEVELOPMENT PRIORITIES.

- THE CURRENT PRIORITIES WERE QUESTIONED, AND SUGGESTIONS FOR CHANGING THE PROCESS WERE DISCUSSED.

SUGGESTIONS:

- IT WAS SUGGESTED THAT THE GOALS SUBMITTED TO THE DIRECTOR OF FOREST PEST MANAGEMENT BE DESCRIBED IN BROAD GENERALIZED CATEGORIES; NOT SPECIFIC CATEGORIES(E.G. DEVELOPMENT OF ALTERNATIVES TO CHEMICALS FOR THE DOUGLAS-FIR CONE MIDGE). THESE WOULD THEN BECOME GUIDES FOR FUNDING PROJECTS WITH THE GREATEST RETURN ON INVESTMENT AT THE TIME THE PROJECTS ARE SUBMITTED.

- IT WAS FELT THAT PRIORIZING GOALS BY CONSENSUS VOTE WOULD BE MORE ACCEPTABLE TO THE COMMITTEE AS A WHOLE, GIVEN WE WERE VOTING ON BROAD CATEGORIES. IT MIGHT THEN BE ACCEPTABLE FOR NON-PRESENT MEMBERS TO VOTE. ALL JUDGED THAT BY MEETING AT A DIFFERENT TIME OF THE YEAR ATTENDANCE SHOULD IMPROVE. REGENERATION INSECTS NEED MORE REPRESENTATION.

- IT WAS FELT THAT THERE SHOULD BE A REASONABLE SPLIT ON PROJECTS SELECTED FOR FUNDING THAT REPRESENT BOTH ECOSYSTEM MANAGEMENT AND TIMBER SPECIES MANAGEMENT.

  RATIONALE: STATE AND PRIVATE REPRESENTATIVES ARE CONCERNED THAT REDUCED ACREAGE FOR TIMBER PRODUCTION IN THE USFS WILL MEAN THAT THEY WILL HAVE TO PICK UP THE SLACK. GIVEN THE TREND TOWARD REDUCING THE USE OF PESTICIDES BY THE EPA, ALTERNATIVES FOR PESTICIDES USED FOR THE PROTECTION OF CONE AND SEED INSECTS IN SEED ORCHARDS NEED TO BE SOUGHT IMMEDIATELY.

- IT IS BELIEVED THAT DEVELOPMENT OF A STRATEGIC PLAN BY THE COMMITTEE WOULD HELP WITH THE DEVELOPMENT OF A SOUND TACTICAL PLAN.

PRIORIZATION OF GOAL CATEGORIES - 6/3/94
BY CATEGORY AND INSECT WITHIN CATEGORY

ALTERNATE CHEMICALS:
- EFFICACY OF MERIT ON LEP'S (RATE, TIME)

ALTERNATIVES TO CHEMICALS:
- CONTARINIA
- LEPTOGLOSSUS
- DIORYCTRIA
- CONOPHTHORUS

BASIC BIOLOGY AND TAXONOMY:
- DIORYCTRIA
- CONOPTHORUS
- LEPTOGLOSSUS
- EUCOSMA

IMPACT:
- LEPTOGLOSSUS

POPULATION MONITORING:
- LEPTOGLOSSUS
- DIORYCTRIA
- CONOPTHORUS

DECISION MODELS:
- LEPTOGLOSSUS
- DIORYCTRIA
- CONOPTHORUS

PRIORIZATION OF GOAL CATEGORIES - 6/24/94
BY CATEGORY AND INSECT

1. **ALTERNATE CHEMICALS:**
   - EFFICACY OF MERIT ON LEPT'S (RATE, TIME)
2. **ALTERNATIVES TO CHEMICALS:**
   - CONTARINIA
   - LEPTOGLOSSUS
   - DIORYCTRIA
3. **BASIC BIOLOGY AND TAXONOMY:**
   - DIORYCTRIA
   - LEPTOGLOSSUS
4. **ALTERNATIVES TO CHEMICALS:**
   - CONOPTHORUS
5. **BASIC BIOLOGY AND TAXONOMY:**
   - CONOPTHORUS
   - EUCOSMA
6. **IMPACT:**
   - LEPTOGLOSSUS
7. **POPULATION MONITORING:**
   - LEPTOGLOSUS
   - DIORYCTRIA
   - CONOPTHORUS
8. **DECISION MODELS:**
   - LEPTOGLOSSUS
   - DIORYCTRIA
   - CONOPTHORUS

Meeting Notes

Rough draft

CONE,SEED, AND REGENERATION INSECTS

A meeting of USFS (FPM) National Steering Committee on Cone, seed, and Regeneration Insect members and other key entomologists in the Northwest - Portland, OR, June 2, 1994

Post-it™ Fax Note 7671
Date
# of pages ▸ 3
To Jack Berry
From Chuck Masters
Co./Dept
Co.
Phone #
Phone #
Fax # (916) 757 - 8383
Fax #

Participants:

- Chris Niwa
- Chuck Masters
- Dave Overhulser
- Nancy Rappaport
- Darrell Roth
- Roger Sandquist

The purpose of the meeting was to: (1) review outcomes from the January, 1994 meeting of the Southern Seed Orchard Pest Committee (Masters), (2) discuss one of the outcomes, a pending "white paper" demonstrating the value of seed orchards, and the need for continued research on cone and seed insects, and (3) to share concerns about the goal selection process used at the Boone, NC meeting of the Steering Committee, suggest change, and to reach concensus research and development priorities in the West.

MEETING NOTES

- Goal statements should be described by generalized categories; not specific projects These would then become guides for making funding decisions. This approach would remove limitations on funding the best projects to achieving a goal as they surface.

  People represented their pet projects; not their region.

  Concern was expressed that by proposing a project you might be stuck with it.

- Given broad categories were being voted on, a consensus vote would be sufficient given the committee was fairly represented. Non-present members should be allowed to vote.

  Meeting at a different time of the year might improve attendance.

- There should be a reasonable split on projects selected for funding, representing both ecosystem management and timber species management. The rationale is that State and private representatives are concerned that reduced acreage for timber production in the USFS will mean that State and private organizations will have to pick up the slack. Given the trend toward reducing the use of pesticides by the EPA, alternatives for pesticides used for the protection of cone and seed insects in seed orchards need to be sought immediately.

  Goals were federal projects. Other organization's interests were not considered.

  Some priorities didn't seem to make sense, e.g. whitebark pine project.

- Development of a strategic plan by the committee would help with the development of a sound tactical plan.

- Regeneration insects need to be better represented. Consider additional reps.

PRIORIZATION OF GOAL CATEGORIES

CATEGORY	INSECT	PRIORITY
ALTERN. CHEMICALS	EFFICACY OF MERIT ON LEPT'S (RATE, TIME)	
ALTERN. TO CHEMICALS	CONTARINA	
	LEPTOGLOSSUS	
	DIORYCTRIA	
	CONOPHTHORUS	
BASIC BIOLOGY, TAXON	DIORYCTRIA	
	CONOPHTHORUS	
	LEPTOGLOSSUS	
	EUCOSMA	
IMPACT	LEPTOGLOSSUS	
POP. MONITORING	LEPTOGLOSSUS	
	DIORYCTRIA	
	CONOPTHORUS	
DECISION MODELS	LEPTOGLOSSUS	
	DIORYCTRIA	
	CONOPTHORUS	

Insects within category were prioritized by the group.

<u>THE GROUP NEEDS TO FINISH PRIORIZATION OF THE LIST BY CATEGORY AND INSECT. PLEASE COMPLETE AND FAX TO C. MASTERS BY JUNE 15.</u>

Also, please make any additions or comments to the meeting notes.

Thank you,

Chuck

Chuck Masters

FAX (206) 330-1742

Appendix E

Single Tree Spray System -
Trip Reports

USDA Forest Service

March 30, 1995

Bob Anderson
Field Representative
USDA Forest Service
Asheville Field Office
Asheville, NC

A BRIEF SUMMARY OF THE LETTER'S CONTENTS

This letter concerns field trips the weeks of March 13 and March 20.

Dear, Mr. Bob Anderson

On **March 13** Darlene Barrett and I went to the Beech Creek Seed Orchard near Murphy, NC to meet with Dr. Gary DeBarr, his technicians and the staff of the Beech Creek orchard to conduct our annual bucket truck safety work shop. This session is held every year and is part of the safety program for operating the bucket truck. We discussed the blue Regional Office bucket truck safety book as well as viewed two aerial lift device videos. We also field inspected our Hi-Ranger and found no serious problems. All participants took part in the let-down procedure training for our bucket truck. This let-down training is practiced monthly by Asheville personnel. Darlene later in the afternoon greased and lubricated the lifting and leveling cables as well as the chain.

That afternoon Dave Rising, Engineer, U. S. D. A., F. S., M.T.D.C. arrived from Missoula, MT with his crew.

On **March 14** all persons concerned with the Single Tree Applicator Study met at the FS work center in Murphy for a briefing and discussion of the upcoming week's work. Attending that meeting were the following:

Larry Barber, Asheville, NC
Darlene Barrett, Asheville, NC
Gary DeBarr, Athens, GA
Chris Crowe, Athens, GA
Mike Cody, Athens, GA
Dave Rising, Missoula, MT
Windy Heyden, Missoula, MT
Mike Huey, Missoula, MT
Mark Wiggins, Missoula, MT
Glen Beaver, Murphy, NC

Asheville Field Office ▪ Asheville, NC ▪ Phone 704-2574323 ▪ Fax

Robin Taylor, Murphy, NC
Clay Logan, Murphy, NC
Steve Ausbon, Washington, NC
Joe Jarman, Trenton, NC

All of the above were with the Forest Service except for Mr. Ausbon and Mr. Jarman who are with the Weyerhaeuser Co. They were present to learn from the experiences of the FS in the West and to return to Washington, NC and set up a similar system for spraying loblolly pine trees. Forest Health will evaluate insect control on this orchard later in the summer.

Dave Rising began the discussion by explaining the previous work of Diana Herzberg, an engineer with MTDC in Missoula. Her work on this project was located in California and Idaho. She is now on medical leave and Dave is uncertain when or if she will return to work. He described her field notes and trip reports which indicate she used two foot sections of schedule 80 1/2" pipe for attachment to the trees. She then plumbed the remainder of the tree with flexible 1/2" rolled pipe. The nozzle was a pop-up rain-bird applying about 0.5 gallon per minute. The trees in the Idaho seed orchard were 25 ft. tall white pines.

I discussed my role in this project and the Southern interest in single tree spray application systems. I noted that every orchard at one time or another has a few trees per acre that need to be protected from insect damage and that it is expensive to aerially treat an entire acre. In addition many private orchards are currently interested in similar treatments on older first generation orchards treating their very best clones. Many of these trees are also pollinated to maximize genetic gain. Therefore, the private orchard has a tremendous investment on a very few trees. Because they are old they are also very tall and ground spraying is very ineffective on trees over 45-50 ft in total height. Many of these old first generation trees are in excess of 70 ft tall. A system to apply pesticide to single trees is necessary and will be used in the South when developed.

Dave and his crew were there to assist our group in setting up the sprinkler systems in NC and to provide further information and documentation to Jack Barry on the usefulness of the spray system. We will provide efficacy data to Jack, documenting the results of year-long spraying on insect damage to cones and seed. Similar work will also be underway on the Weyerhaeuser Orchard near Washington, NC.

During this meeting we prepared a list of supplies to purchase from the local hardware store including schedule 80 1/2" gray plastic pipe, and various fittings to attach the pipe to the trees. After shopping, we discovered that the schedule 80 pipe we wanted was not available in Murphy. The previous weekend I was also unable to locate this type of pipe in the Home Depot outlet in Asheville.

After assembling the necessary list of plumbing supplies and substituting 1/2" and 3/4" schedule 40 PVC pipe we reassembled at the orchard and in the afternoon and set up two trees with nozzle systems. After first testing the two units Dave and I determined that the flow rates of the two nozzles used by Diana in Idaho were too low and not satisfactory for eastern seed orchards.

We called the RainBird company headquarters and learned that there were other nozzles that would work in our nozzle bodies and that would have higher flow rates. Dave called his office in Montana and had someone go to the local RainBird dealer and purchase nozzle tips with three different orifice sizes for further testing. These nozzles tips were sent overnight to Murphy, NC arriving the next afternoon.

On Wednesday **March 15** crews purchased the remainder of the plumbing supplies and assisted Gary DeBarr with the layout of a research project he is conducting on the Beech Creek. Glen Beaver located several sections of schedule 80 1/2" pipe for testing. We also acquired additional sections of 1/2" and 3/4" white plastic pipe. In the afternoon we returned to the orchard and tested the nozzle tip producing the highest flowrate, i.e. 3.7 gpm at 30 psi. We determined that this looked about right (spray diameter and coarseness of spray) and that we would go with the number 15F nozzle orifice. We also looked at the method of attachment to the trees and determined that the television cable stand-offs that we had bought at Radio Shack worked well. These are fitted with a plastic insert which was removed and the PVC pipe clamped inside the opening of the stand-off. In the case of 3/4" pipe, the hole size is enlarged before gripping the plastic pipe. We also determined that schedule 80 1/2 pipe is too flexible. We further determined, we needed to use 20 ft sections of pipe. Because of the small diameter of branches in the upper 5-10 ft it is necessary to brace or attach the pipe to large lower limbs. This requires the pipe to be fairly rigid. In some cases the final 10 feet may be unsupported.

Tree selection was based first on being one of the 10 trees that was artificially pollinated last spring. These trees currently bear 1 year old conelets that will be harvested this coming August and the orchard is very interested in their protection. Asana XL is not labeled for control of the white pine cone beetle, but others in the West have reported success reducing damage caused by western conebeetles attacking ponderosa and western white pine.

On **March 16** we completed purchasing all the necessary fittings for the 18 trees we intended to spray in this evaluation. We ultimately used both 1/2" and 3/4" schedule 40 white PVC pipe. The reason for using two sizes is because we decided to further the test pipe diameter. We will evaluate its ability to hold up the RainBird pop-up nozzle body and its ability to withstand UV sunlight over time.

On **March 17** we tagged our trees in preparation for damage assessment. In total 10 tagged branches were located on each of 30 trees. Some trees that contain spray systems were not tagged because untreated clonal matches were not found.

We returned to the Beech Creek on **March 20** to continue to tag trees used for inventory. The tagging operation lasted into mid-day of March 21. As we paired up the spray trees with unsprayed trees we determined that in the Cherokee source there was one tree for which there was no suitable match. I decided not to spray this tree and to remove the spray system for later testing and evaluation. We ended up with only 17 treated trees and 15 untreated trees.

In the afternoon of the **21st of March** we began the field testing of the 17 single tree spray systems. In many cases trees were close enough together to attach the hoses of more than one tree together into a multiple tree spray system. The most trees used in a multiple tree system was three. We attempted to spray 4 trees in one system but the results were not satisfactory. I think what happened is that because of the elevation differences between trees the pressure on the nozzles were not equal and thus the flow rates varied between nozzles. In this case we reduced the number of trees to 3.

We discovered that the connections where the rolled black 1/2" pipe was made, both on the ground and in the tree, in many cases leaked. The repair of leaking pipes and fittings took all of March 21 and March 22. Some of the repairs were made using duct tape added to the black pipe and in others we used liquid paste Teflon. Both seemed to work but the liquid paste was easier to apply and use. Hose clamps were used to tighten and hold the pipe to the fittings.

On **March 22** after completing the pressure testing and needed repair to each single tree system we gathered up our supplies for the first operational spray of the single tree sprayer system. This included getting the pesticide from the pesticide building, locating the spray safety equipment, and determining the amount of spray material necessary to obtain coverage and calculating the amount of Asana XL to mix in the spray tank. We also determined the duties of each participant in the actual spray application. Clay Logan ran the tractor and Darlene Barrett attached the hose from the tractor to the individual tree spray systems. She also mechanically turned the level that controlled the flow of solution into the individual spray systems. The side of the spray tank was calibrated into 5 gallon units and depending on the number of trees being sprayed she allowed 5 gallons of spray to be applied to each tree before turning off the system and draining the excess material back into the spray tank. We determined during these practice runs that we needed an inline shut off valve at the end of the tractor hose. This would require the crew to drain less material back into the tractor spray tank after each tree spray. A shut off was acquired and used on March 23.

We determined that it was best if we positioned the tractor downhill of the tree(s) to be sprayed. We felt this would facilitate draining the lines and hoses of excess spray material. In some cases the tractor was perhaps 25 feet below the ground level of individual spray trees. This would require extra pressure at the sprayer to move the spray material up hill. We determined the spray pressure for most trees at the tractor needed to be between 50 and 70 psi to deliver what appeared to be a satisfactory spray stream on top of the trees.

Darlene charged the batteries for our safety spray systems and determined that one of the two batteries was dead and would not take a charge. We carry additional pesticide safety gear on the bucket truck and that is what I used March 23. We have an extra battery for our forced air Breath Easy system but it was in Asheville. We had never before experienced battery failure with this system. After every use we continue to operate the unit until the battery no longer has a charge per manufacture recommendations. The batteries are then recharged prior to the next use. The battery that failed was two years old and was last used in October 1994.

Early in the morning of **March 23** we arrived at the orchard and after putting on our spray safety equipment mixed 310 ml Asana XL in 110 gallons water. I anticipated it would take 85 gallons of spray solution to treat 17 trees. We started the actual spray application at 8:00 am and concluded the operation around 10 am. Wind conditions were generally calm through 9:30 and picked up toward the end gusting to perhaps 5 mph. When we finished the final tree we decided to return to the first setup (3 tree multiple set) and apply additional pesticide because Darlene had not applied the entire 5 gallons per tree. She began to calculate the amount of material being applied to this group of trees when the flow began not when it reached the top of the pipes and was discharging from the nozzles.

I timed the application to single trees and it took 1 minute 15 seconds to apply 5 gallons of material to a tree at approximately 50 - 60 psi. The time required to treat 3 tree clusters was 2 minutes 30 seconds at 65 psi.

After the completion of the spray operation and after we cleaned up the sprayer and other equipment we met to discuss the overall project and to capture our ideas for this report. The recommendations that we came up with are listed below.

1. Only 3/4 " pipe should be used. Sometime this summer we will replace the 1/2 " pipe with larger diameter 3/4 " schedule 40 pipe.
2. We need to further test different RainBird nozzles to determine if the pop-up design is really needed. This extra weight on the end of 1/2" or 3/4 " pipe often keeps the system from remaining vertical.
3. A spray evaluation is needed to determine within crown coverage on large diameter trees.
4. Improvements in spray system attachment improvements need to be further tested and developed.
5. Quick release couplings are needed and should be installed as soon as possible.
6. The spray system pump and tank used on the Beech Creek is normally used for applying herbicides and another pump should be purchased solely for the use of insecticides.
7. A return in-line pump should be installed to rapidly drain the spray lines to expedite the spraying of these trees. Because wind conditions are only optimal for a short period of time it is essential to complete the spray process as rapidly as possible. This speed is also essential if this new technology is to be adopted by orchard managers that would spray a larger number of trees.

Larry R. Barber
Entomologist

March 30, 1995

TRIP REPORT

Subject: MTDC staff visits to Coeur d'Alene, ID and Murphy, NC tree seed orchards

Dates: March 8 and 13-17, 1995

Prepared by: David W. Rising

Objective: To learn about the sprinkler systems installed in Coeur d'Alene in 1994, and then to use this information while installing similiar systems in the Beech Creek Seed Orchard in Murphy, NC.

Contacts:

Sandie Kegley, USDA-FS Coeur d'Alene Field Office, Coeur d'Alene, ID
Joe Myers, Nursery Superintendent, USDA-FS Coeur d'Alene Nursery, Cd'A, ID

Steve Ausbon, Weyerhaeuser Co., Washington, NC
Larry Barber, USDA-FS SEFES, Forest Health, Ashville, NC
Darlene Barrett, " " " " "
Glen Beaver, Orchard Manager, USDA-FS Beech Creek Seed Orchard, Murphy, NC
Michael Cody, USDA-FS SE Station, Forestry Sciences Laboratory, Athens, GA
Christopher Crowe, " " " " " " "
Gary DeBarr, " " " " " " "
Joe Jarman, Weyerhaeuser Co., Trenton, NC
Clay Logan, USDA-FS Beech Creek Seed Orchard, Murphy, NC
Robin Taylor, " " " " " " "

Windy Hayden, USDA-FS Technology and Development Center, Missoula, MT
Mike Huey, " " " " " " "
Bill Kilroy, " " " " " " "
Dave Rising, " " " " " " "
Mark Wiggins, " " " " " " "

Activities:

On 3-8-95, the above five MTDC personnel travelled to the Coeur d'Alene Nursery in Cd'A, ID where they and Sandie Kegley and Joe Myers looked at and discussed last year's sprinkler installations. The purpose of this trip was to familiarize MTDC technicians with what Diane Herzberg had done there so that they could repeat the installation in Murphy, NC.

On 3-13-95, Hayden, Huey, Rising and Wiggins travelled to Murphy, NC.

On 3-14-95, all of the above people except Kegley, Myers and Kilroy met at the Tusquitee RD offices in Murphy. MTDC personnel brought all the sprinklers and fittings necessary to duplicate the Couer d'Alene installation in Murphy, except for the rigid and flexible plastic pipe. After meeting in the morning, people split up into several groups, did some shopping for supplies, and met in the field at the Beech Creek Seed Orchard a few miles outside of Murphy that afternoon. Sprinklers were placed in two 50-55 foot high trees using the truck-mounted lift provided by Larry Barber. Each system used a Rainbird 1803 pop-up sprinkler head with XS-360 Xeri-Spray nozzle and XBA-1800 adapter. One was at the top of an 8 1/2 foot piece of 1/2 inch EMT steel electrical conduit, and the other at the top of a 10 foot piece of 1/2 inch Schedule 40 rigid plastic pipe (plastic conduit was actually used). One 80 foot length of 1/2 inch, 125 psi. flexible plastic pipe was connected to the bottom of the verticle EMT or rigid plastic pipe in each treetop, and fed through the branches to the ground near the trunk of an adjacent tree. When a tractor

mounted, PTO driven pump belonging to the orchard was connected to one of the spray systems, it was determined that the approx. 0.5-0.6 gpm available through the XS-360 nozzle (wide open) was inadequate to do what Larry Barber wanted done. We next tried a 8F-FLT nozzle and, although the flow was somewhat greater, the approx. 1.5-1.6 gpm it flowed was still inadequate. The day ended with a call placed to Missoula and additional nozzles being sent by Fed Ex to Murphy.

On 3-15-95, additional supplies were purchased in the morning, the nozzles delivered at noon, and testing performed in the orchard in the early afternoon. Of the three larger sizes of full circle nozzles available for the 1800 heads (10F-LA, 12F and 15F), the 12F and 15F were tested. Although the 12F at approx. 2.6 gpm flowed more than the 8F-FLT had, the 15F at approx. 3.7 gpm was judged to be the best choice to install in the orchard in quantity. The first two systems were removed (8 1/2 foot EMT and 10 foot rigid plastic). By the end of the day, seven systems using 20 foot lengths of either 1/2 inch or 3/4 inch Schedule 40 rigid plastic pipe and 80 foot lengths of 1/2 inch flexible plastic pipe were installed.

On 3-16-95, it was decided to install 18 systems instead of the originally requested 14 because 18 sets of sprinklers, nozzles, and fittings had been supplied by MTDC. However, because only 11 lengths of 1/2 inch Sch. 40 pipe were available, seven of the 18 were made up using 3/4 inch Sch. 40 pipe. By the way, the only Sch. 80 rigid plastic pipe available in Murphy were some dark gray 20 foot lengths of 1/2 inch pipe that seemed to be possibly less rigid than the white Sch. 40 pipe. A total of 18 systems were made up by the end of the day, and 14 of those were installed in trees when the MTDC crew left the orchard.

As was mentioned earlier, testing was done using a tractor mounted, PTO driven pump with attached plastic tank, plumbing, valve and pressure gauge. The outlet after the valve had a hose thread and we installed several more feet of hose before attaching an inline filter. It was felt that even with the small plastic strainers provided with each nozzle installed, it would be a good idea to keep material from entering the piping should a pump fail, etc. A length of garden hose was used between the filter and the 80 foot length of 1/2 inch flexible pipe coming down each tree.

Notes were taken of the two different size pipe typical installations for inclusion in a report to be prepared on this project. Black and white pictures, color slides and video footage were shot during the several days in Murphy. The video footage will be edited into a short segment and will be available to anyone interested in putting sprinklers in the tops of trees. Larry Barber, Glen Beaver, and the rest of the people working in the orchard have been using the sprinklers and are continuing to find better ways of doing things. Their results will be forthcoming in subsequent memos.

One additional subject should be discussed. When we went to Murphy, it was our intent to start out by duplicating the systems installed in Couer d'Alene. In hindsight, it would seem to be easier, cheaper and more straight forward to skip the pop-up sprinkler bodies and use Rainbird PA-8S Plastic Shrub Adapters instead. These have the same 1/2 inch FPT thread on the "bottom", the male thread onto which the nozzles screw on the "top", and will accept the nozzle strainers. This information was FAXED to Steve Ausbon of Weyerhaeuser Co. because he is planning to install similar systems in 200+ trees as soon as possible. And Larry Barber may also be planning on trying some sprinkler systems without pop-up heads in the Beech Cr. Seed Orchard.

David W. Rising
FPM Program Leader

MESSAGE SCAN FOR JACK BARRY

To Seed and Cone
To N.Lorimer:w01c
To R.Anderson:s29a
To H.Thistle:r01a

From: Jack Barry
Postmark: Mar 31,95 8:24 AM   Delivered: Mar 31,95 8:24 AM
Status: Previously read
Subject: Forwarded: Single Tree Sprinkler Systems in the Beech Creek Seed Or

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Comments:
From: Jack Barry:R05H
Date: Mar 31,95 8:24 AM
Good example of responding to cooperator needs with engineering support. Tree sprinkler system was Nancy Rappaport's (PSW's) idea and MTDC followed up at FPM's request under the FPM Technical Services contract. The obvious payoff is reduced costs and reduced use of pesticides. Good work. Jack

Previous comments:
From: David Rising:R01A
Date: Mar 30,95 3:57 PM
Please share this with others in your offices who were involved, and thanks to all for helping us get this done. It was a good, productive trip and I know that Larry and Glen will be sharing their experience with these systems with us as they test them and make recommendations. Dave Rising

------=======X=======-------

MESSAGE DISPLAY FOR JACK BARRY

To   Jack Barry:R05H

From: Nancy Rappaport:S27A
Postmark: Mar 31,95 9:42 AM   Delivered: Mar 31,95 9:44 AM

Subject: Reply to a reply: Forwarded: Single Tree Sprinkler Systems in the B

Reply text:
From: Nancy Rappaport:S27A
Date: Mar 31,95 9:42 AM
Yes; actually, Diane may have given me one, but it's been so long that I need to go back through my files. I remember that she was extremely responsible about documenting the processes. I can spend some time on this this weekend at home while my husband does the taxes. The poster presentation for last year's IUFRO meeting is on my home computer, so the skeleton for a paper is there already. Did I tell you that the French and Belgians are also talking about using the system? Also, a group of Chinese photgraphed every square inch of the poster. Afterward, they told me that one of their colleagues had produced an identical system!

Preceding message:
From: Jack Barry:R05H
Date: Mar 31,95 9:37 AM
Not sure but we will provide the write-up even if someone else needs to do it. I believe you will need a description of the system and how it operates. Jack

From: Nancy Rappaport:S27A
Date: Mar 31,95 9:30 AM
Thank you for your support with this project, Jack. I can write up most of the note within a short time, but I would need some help from Diane Herzberg with technical parts (an engineer I'm not). I understand that she's on an extended stress-related leave; do you know if she's available at all?

From: Jack Barry:R05H
Date: Mar 31,95 9:07 AM
Nancy, we do need a note. There is no publication to reference this concept. It could really take off so would be good to have credit properly assigned. Thanks again for getting this started. Jack

From: Nancy Rappaport:S27A
Date: Mar 31,95 8:59 AM

-------X-------

MESSAGE DISPLAY FOR JACK BARRY

To   Jack Barry:R05H

F om: Nancy Rappaport:S27A
Postmark: Mar 31,95 10:05 AM   Delivered: Mar 31,95 10:08 AM
Status: Previously read
Subject: Reply to a reply: Forwarded: Single Tree Sprinkler Systems in the B

Reply text:
From: Nancy Rappaport:S27A
Date: Mar 31,95 10:05 AM
Sounds great!

Preceding message:
From: Jack Barry:R05H
Date: Mar 31,95 9:52 AM
Example of rapid fire, technology transfer - I had not heard that Nancy. Glad you presentyed the poster. I will mention the technology and its interest, during the talk that Harold and I will be giving at the Nat. Silv. meeting at Mescalero in May.

From: Nancy Rappaport:S27A
Date: Mar 31,95 9:42 AM
Yes; actually, Diane may have given me one, but it's been so long that I need to go back through my files. I remember that she was extremely responsible about documenting the processes. I can spend some time on this this weekend at home while my husband does the t--es. The poster presentation for last year's IUFRO meeting is on ome computer, so the skeleton for a paper is there already. Did I tell you that the French and Belgians are also talking about using the system? Also, a group of Chinese photgraphed every square inch of the poster. Afterward, they told me that one of their colleagues had produced an identical system!

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-------X-------

Appendix F

Jim Rafferty Report on Aerial Application to Oregon Seed Orchards

Jim Rafferty

Meteorology Division
Dugway Proving Ground
Technical Note 94-90-1
08 June 1994

FSCBG ANALYSIS OF THE 1990 OREGON SEED ORCHARD TRIALS

BACKGROUND

During April and May 1990, the USDA Forest Service (FS) conducted trials to assess the effectiveness of aerial spraying to control insect cone pests at two Douglas-fir seed orchards in Oregon (Sandquist, 1990). Two applications of the insecticide Asana XL were applied from a Hiller Soloy 12D helicopter at the Oregon Department of Forestry's Schroeder Seed Orchard near St. Paul and the Bureau of Land Management's Horning Tree Seed Orchard near Colton. Ground sampling grids for the measurement of surface deposition were deployed at each of two spray blocks at both orchards.

Subsequent to the applications, a technique for assessing forest density using sky radiation measurements was developed by Dugway Proving Ground (DPG) for the FSCBG spray dispersion model (Teske and Curbishley, 1990). During July 1991, measurements were made using the Li-Cor LAI-2000 plant canopy analyzer to measure the forest density at the seed orchard spray blocks. The FS has asked the Meteorology Division: (1) to evaluate the FSCBG model's ability to predict canopy penetration using the measured deposition and (2) provide the model inputs from the radiation measurements for possible inclusion in an FSCBG library of canopy inputs.

SAMPLING PROCEDURES

At each orchard, two blocks were selected for deposition measurements and two spray applications were made at each block for a total of eight deposition measurement trials. Table 1 lists the blocks sprayed and the dates and times of the spraying.

Table 1. Spraying Chronology.

Spray Block	Application 1		Application 2	
	Date (1990)	Time (PST)	Date (1990)	Time (PST)
Schroeder-Nehalem	4 April	0756	1 May	- -[a]
Schroeder-Vernonia	5 April	0740	2 May	- -[a]
Horning-Block 12	18 April	1237	9 May	0646
Horning-Block 14	12 April	0755	8 May	0732

[a] The time of spray was not recorded for these applications.

Deposit cards in card holders were used to measure the deposition within the spray block. The drop stains were hand counted by the FS and a stain to drop diameter ratio of 2 was used to calculate the drop diameter and mass distribution. Because of the regular spacing of the trees in rows, the deposition was measured using a grid that was irregularly spaced to achieve a random sample of below canopy deposition. Figures 1 through 4 illustrate the tree and the sampler locations in the four spray blocks. The calculated mean deposits for all cards within each block are listed in Table 2. The fraction of applied deposition was calculated by dividing the mean deposition by the application rate of 10 gal ac^{-1} (9325.5 mg m^{-2}).

Characterization runs were made before each application to determine the drop size distribution and application rate of the system. The mean application rate calculated from the results of seven of the characterization runs was 7745.5 mg m^{-2} or 0.831 (σ=0.124) of the intended application rate. The excluded characterization run was for the first application at Horning Block 14 which yielded an application rate 2.774 times the intended application rate. The mean deposition on the block for that trial (Table 2) is also approximately 3 times the mean deposition for the other trials. Because the characterization run and the below canopy deposition indicate a tripled application rate for the first application for Block 14 at Horning, an application rate of 30 gal ac^{-1} was assumed in calculating the observed canopy penetration ratio.

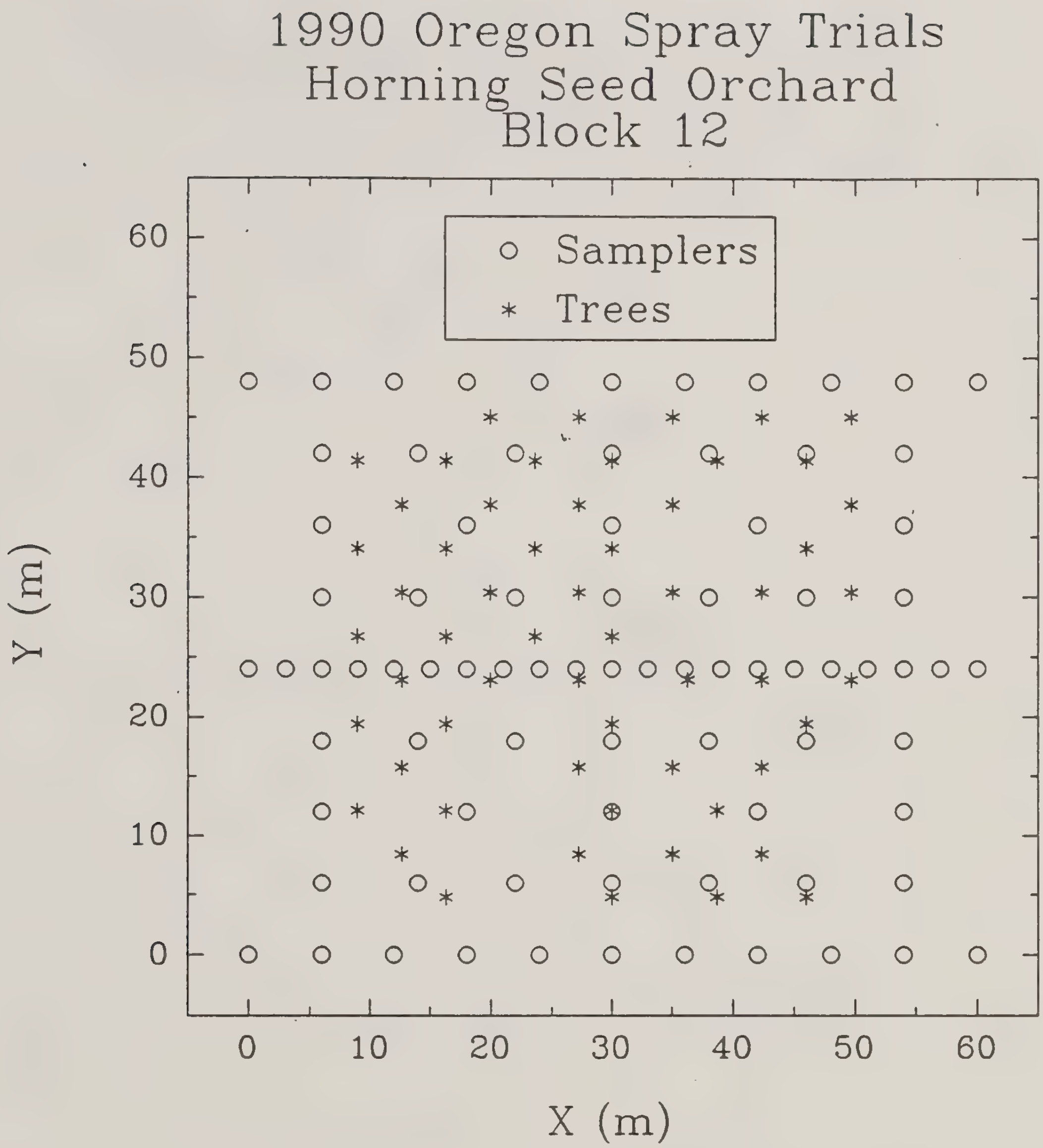

Figure 1. Locations of the trees and spray deposit cards in Block 12 of the Horning Tree Seed Orchard.

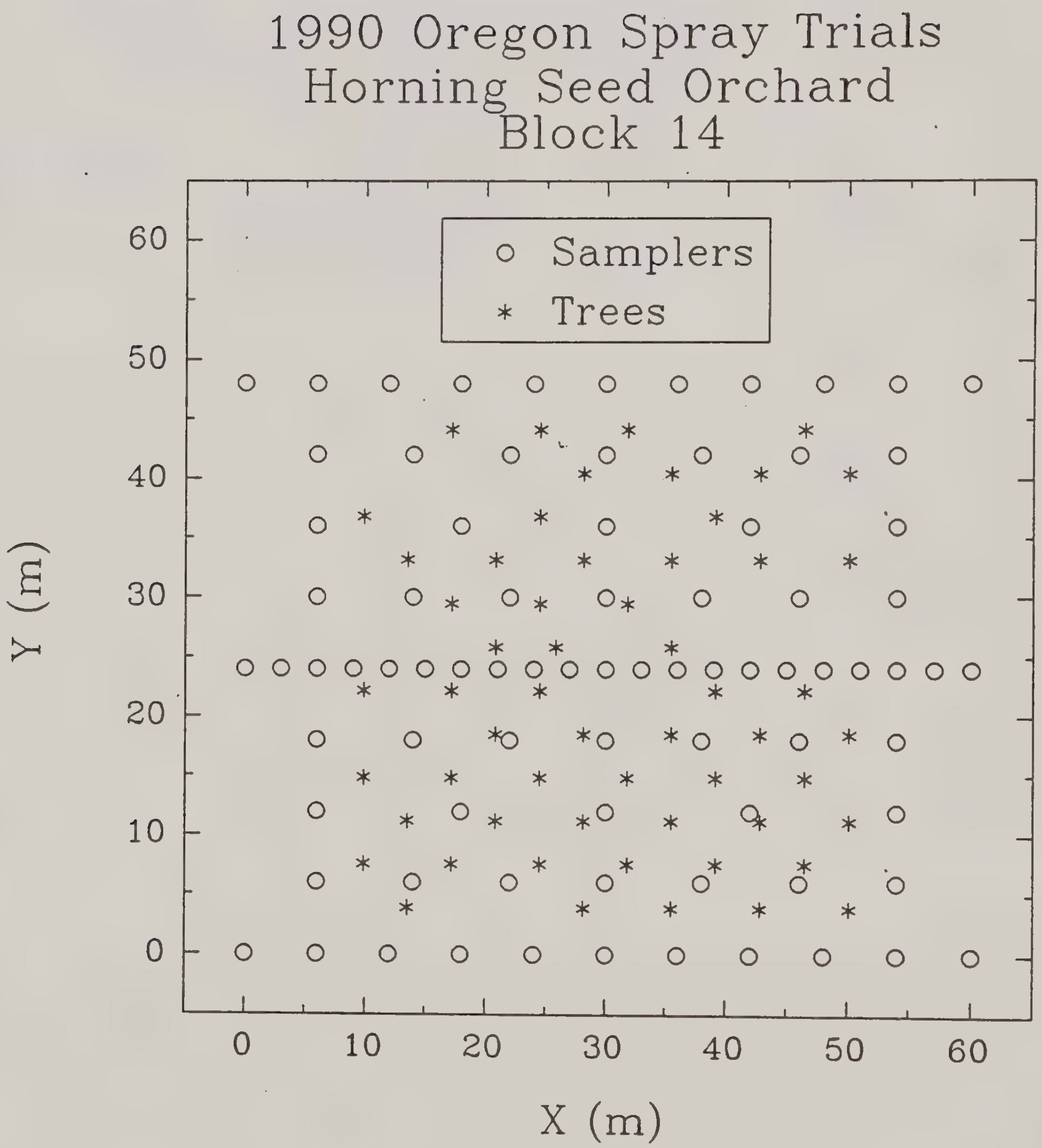

Figure 2. Locations of the trees and spray deposit cards in Block 14 of the Horning Tree Seed Orchard.

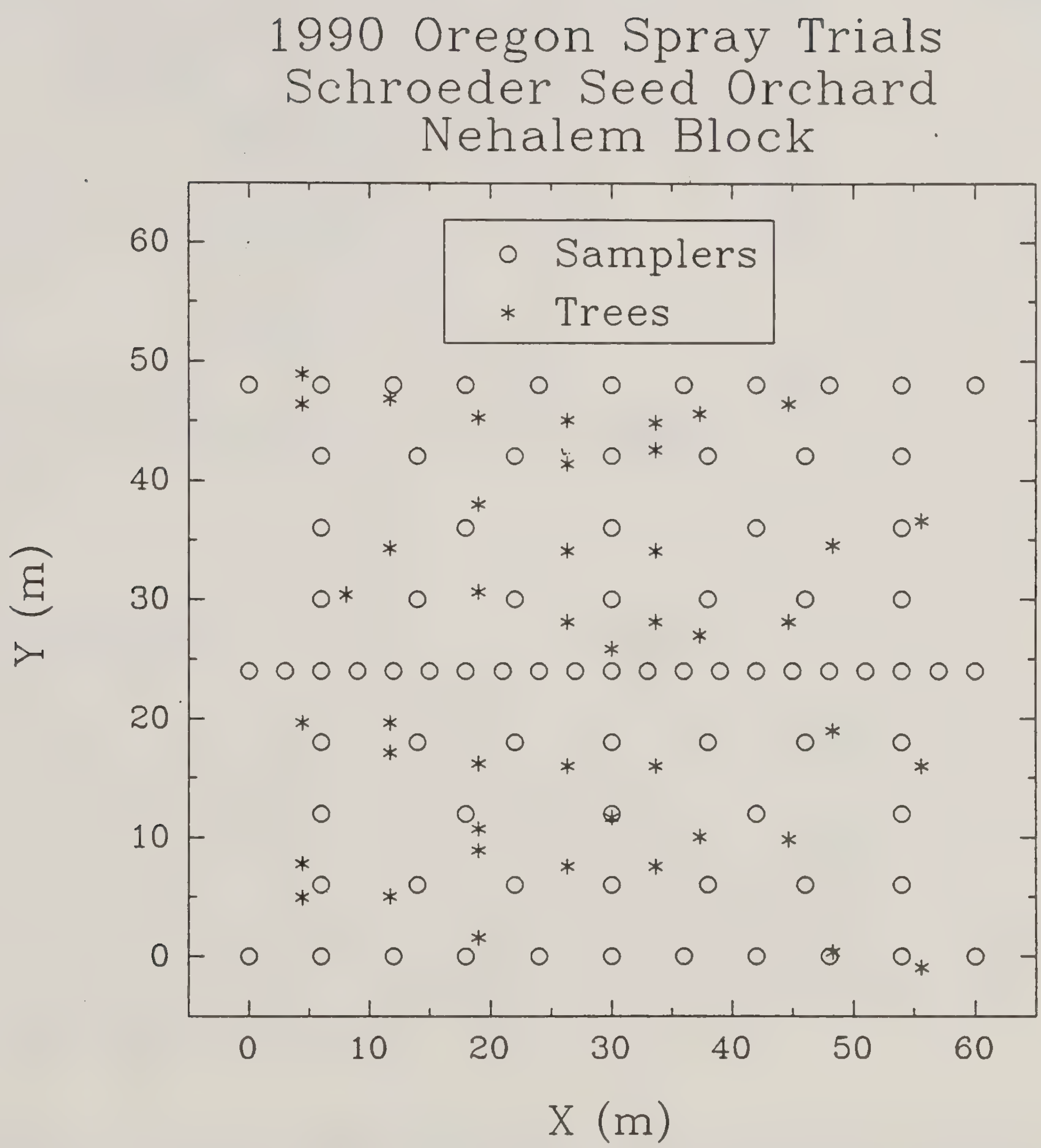

Figure 3. Locations of the trees and spray deposit cards in the Nehalem Block of the Schroeder Seed Orchard.

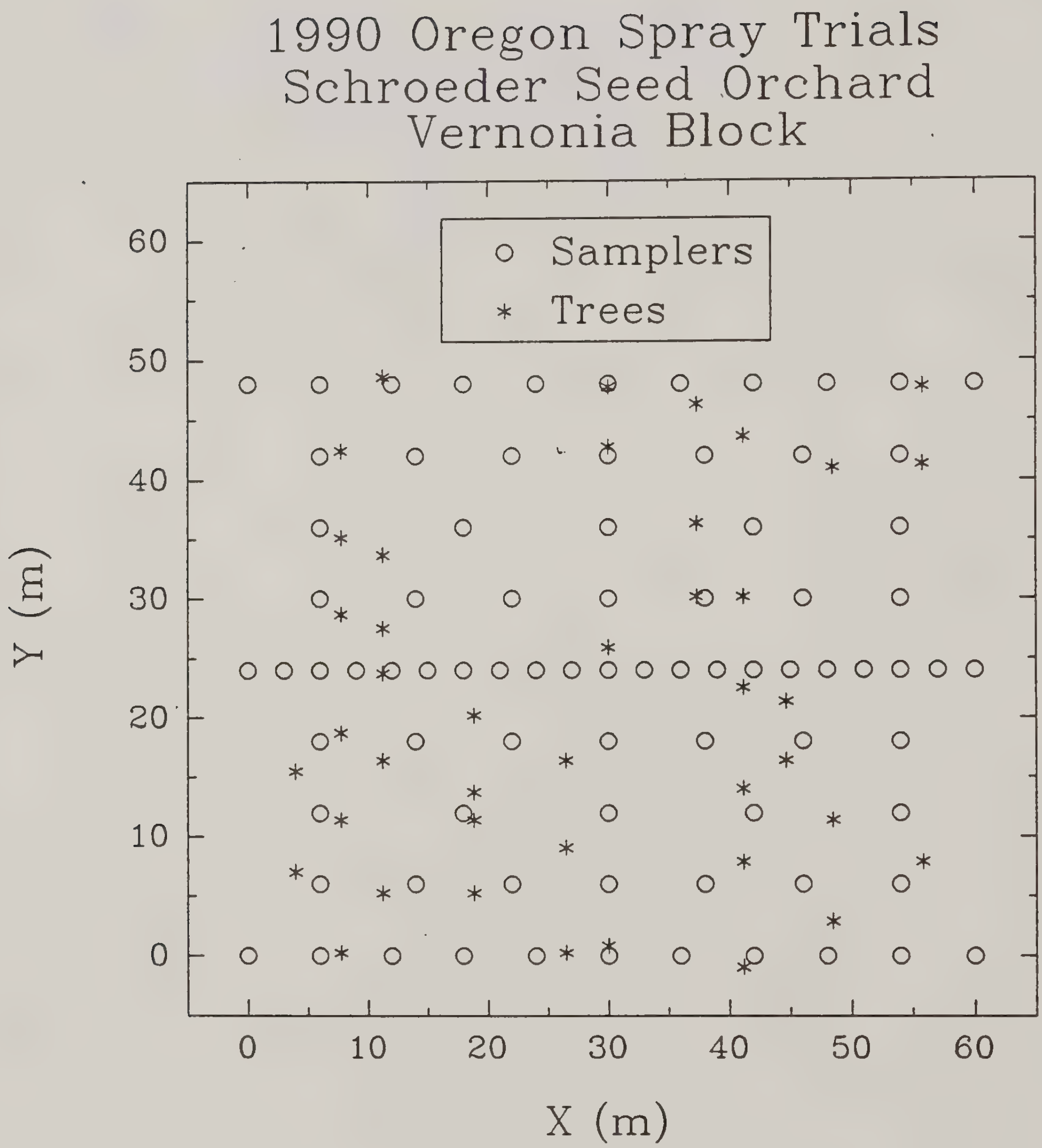

Figure 4. Locations of the trees and spray deposit cards in the Vernonia Block of the Schroeder Seed Orchard.

Table 2. Measured Mean Deposition

Orchard	Block	Application	Mean Deposition (mg m^{-2})	Fraction of Applied
Horning	B12	1st	6607	0.708
"	"	2nd	3578	0.384
"	B14	1st	12,540	0.448[a]
"	"	2nd	4896	0.525
Schroeder	Nehalem	1st	6429	0.694
"	"	2nd	7205	0.773
"	Vernonia	1st	4581	0.491
"	"	2nd	2943	0.316

[a] An application of 30 gal ac^{-1} was assumed to calculate the observed canopy penetration.

CALCULATION PROCEDURES

The canopy penetration calculations were made using Version 4.3 of the FSCBG spray dispersion model. No wake or evaporation calculations were made, and the Li-Cor canopy option was selected with a linear leaf area density profile. The drop-size distribution used in the calculations, which was a mean of those measured during the eight characterization runs, is listed in Table 3. The sky radiation measurements made in the blocks and used in the model are listed in Table 4.

During the spray period, meteorological measurements were made at the seed orchards by the FS's Missoula Technology Development Center (MTDC) (Lassila and Ekblad, 1991) using two EMCOT measurement stations (Ekblad et al., 1990). Each station was equipped with instruments that measured wind speed and direction (z= 8 m), temperature at (1.0 and 7.0 m), vertical wind velocity, and relative humidity. Table 5 contains the meteorological inputs to the model that were derived from the MTDC measurements and surface observations made by the National Weather Service (NWS) at Salem, Oregon. Cloud

cover observations, which are used to calculate the net radiation index, and atmospheric pressure were taken from the NWS records. Wind speeds and directions, relative humidity, and the temperature at the upper level of the EMCOT stations were determined using a mean of the 10-minute averaged data from each of the two EMCOT stations.

Table 3. Mean Drop-Size Distribution.

Upper Drop Diameter (μm)	Cumulative Mass Fraction	Upper Drop Diameter (μm)	Cumulative Mass Fraction
25	1.04×10^{-5}	1000	0.825
50	2.94×10^{-4}	1050	0.843
100	4.13×10^{-3}	1100	0.862
150	0.0174	1150	0.873
200	0.0390	1200	0.879
250	0.0831	1250	0.929
300	0.127	1300	0.944
350	0.171	1350	0.951
400	0.220	1400	0.956
450	0.269	1450	0.961
500	0.342	1500	0.976
550	0.402	1550	0.976
600	0.465	1600	0.976
650	0.517	1650	0.976
700	0.545	1700	0.989
750	0.616	1750	0.989
800	0.676	1800	0.989
850	0.710	1850	0.989
900	0.730	1900	0.989
950	0.765	1950	1.00

Table 4. Sky Radiation Measurements.

Zenith Angle (deg)	Fraction of Above Canopy Radiation		
	Horning Block 12	Horning Block 14	Schroeder Nehalem
7	0.3207	0.3107	0.5856
23	0.2426	0.3452	0.5331
38	0.2274	0.2954	0.5029
53	0.1782	0.2476	0.4882
68	0.09275	0.1708	0.3453

RESULTS AND CONCLUSIONS

Table 6 compares the canopy penetration calculated by the FSCBG model with the observations. For two of the trials, the canopy penetration is over or underpredicted by a factor of 2. The predictions for the remaining six trials are within 30 percent of the measurements. The median predicted to observed penetration ratio is 0.829. The predicted canopy penetration values in Table 6 show a distinct similarity to the sky radiation fractions for the smallest zenith angle, which are listed in Table 4. This effect occurs because the small zenith angle of the radiation measurements is equivalent to the steep angle that the majority of the drops follow through the canopy. The steep fall angle is a result of the fairly large drop sizes and low wind speeds.

The canopy radiation measurements presented here are for an artificial forest and do not adequately represent the species diversity and age diversity of trees in a natural forest. However, this comparison, while not representative of natural forests, illustrates the usefulness of sky radiation as a convenient and accurate tool for the measurement of canopy density as an input to the FSCBG model's canopy penetration option. Measurements of sky radiation within a natural Douglas-fir forest should produce FSCBG canopy penetration predictions with similar accuracies.

Table 5. Meteorological Inputs to FSCBG.

Parameter	Schroeder				Horning			
	Nehalem		Vernonia		Block 12		Block 14	
	#1	#2[a]	#1	#2[a]	#1	#2	#1	#2
Atmospheric Pressure (mb)	1008	1015	1009	1015	1008	1008	1012	1015
Net Radiation Index	2	1	2	1	2	2	2	3
Temperature (°C)	10	8	6	11	11	9	9	4
Relative Humidity (%)	75	93	100	97	94	63	94	100
Wind Direction (deg)	349	321	009	170	215	017	055	042
6.1-m Wind Speed in the Open ($m\ s^{-1}$)	0.9	0.7	0.5	0.4	1.6	1.7	0.7	1.6

[a] Inputs assuming a spray time of 0720 PST.

Table 6. FSCBG Calculated Canopy Penetration.

Orchard	Block	Application	Calculated Penetration Fraction	Predicted to Observed Ratio
Horning	B12	1st	0.304	0.429
		2nd	0.304	0.792
Horning	B14	1st	0.373	0.833
		2nd	0.374	0.712
Schroeder	Nehalem	1st	0.638	0.919
		2nd	0.638	0.825
Schroeder	Vernonia	1st	0.638	1.30
		2nd	0.638	2.02

REFERENCES

Ekblad, R., K. Windall, and B. Thompson, 1990: EMCOT weather station. USDA Forest Service, Missoula Technology Development Center, Missoula, MT.

Lassila, D. and R. Ekblad, 1991: Meteorological data supplement to aerial applications of insecticide in Douglas-fir seed orchards. Report 3400 Pest 9134-2808-MTDC, USDA Forest Service, Missoula Technology Development Center, Missoula, MT.

Teske, M.E., and T.B. Curbishley, 1990: Forest service aerial spray computer model FSCBG 4.0, user manual. Report FPM 91-1, prepared by Continuum Dynamics Inc. for USDA Forest Service, Forest Pest Management, Davis, CA.

Appendix G

Tactical and
Strategic Planning Issues

Suggested updates to
current tactical plan

Goal # 4:

Western cone beetles:

* Trans-pityol has been identified ~~[illegible]~~ from ♀ *Conophthorus ponderosae* from western white pine.

* Trans-pityol was shown to attract ♂ *C. ponderosae* in a mixed conifer stand ~~[illegible]~~ that has traditionally suffered high cone losses from *C. ponderosae*

  Research is underway ~~for~~ on trap & releasor systems.

Seed bugs:

* No progress except for insecticide trials & implication of seed bugs in sugar pine conelet abortion.

Dioryctria:

* Cuticular hydrocarbons have been identified for a few species of cone worms.

STRATEGIC PLAN:

CONE, SEED, AND REGENERATION INSECT TECHNOLOGY DEVELOPMENT

MODEL 1: The insect model

I. Cone and seed insects

A. *Leptoglossus*

1. Basic biology and taxonomy
2. Impact
3. Monitoring
4. Control methods
   a. Insecticides
   b. Pheromones
   c. Biological control
   d. Silviculture (burning, sanitation, etc.)

B. *Conophthorus*

1. Basic biology, etc....

C. *Dioryctria*

D. *Cydia*

E. *Contarinia*

F. *Tetyra*

G. *Eucosma*

H. *Megastigmus*

I. *Choristoneura*

II. Regeneration insects

A. *Rhyacionia*

B. *Eucosma*

C. *Pissodes*

D. Gouty pitch midge (*Cecidomyia piniiopis*?)

Model 2: The research phase model:

Mission statement: Our goal is to develop IPM systems to ensure an adequate supply of genetically appropriate seeds and seedlings for reforestation, restoration, and maintenance of healthy future ecosystems.

Strategic statements:

* We will manage insects as necessary and appropriate to provide adequate supplies of seeds and seedlings.

* Ecosystem management shall include both major and minor species. FPM technology development projects shall focus on both ecosystem management and timber-based management, and value shall be optimized by favoring for funding those projects that serve this dual purpose.

* Cone, seed, and regeneration insect damage is far less visible than that caused by bark beetles and defoliators, so their impacts, both ecological and economic, have not been fully appreciated in the past. Future technology development funding should reflect the true importance of cone, seed, and regeneration insect species.

Template for outline for "research phase" strategy:

I. Basic biology and taxonomy

 A. *Conophthorus* spp.

 B. *Leptoglossus* spp.

 C. etc....

II. Impact assessment

III. Development of monitoring methods (including economic thresholds)

IV. Control methods

 A. *Conophthorus* spp.

  1. Insecticides

  2. Pheromones

  3. Biological control

  4. Silviculture

 B. *Leptoglossus* spp., etc.

MESSAGE DISPLAY FOR JACK BARRY

To j.barry:r05h

- .l: Roger E. Sandquist:R6/PNW Host: R06C
Postmark: Jul 05,94 3:14 PM Delivered: Jul 05,94 3:15 PM

Subject: Goal 4 WWPine update

Message:
Under Actions, Seed Bugs change Years 1 - 3 to read---Identify impacts and marker pheromones. Thats all we have; no progress to report. I enjoyed the meeting, am looking forward to working on the strategic plan later this year.

-------========X========-------

MESSAGE DISPLAY FOR JACK BARRY

To Jack Barry:R05H
M.Weiss
N.Lorimer
CC J.Cota

From: Jesus A. Cota:WO Host: W01C
Postmark: Jun 21,94 10:08 AM Delivered: Jun 21,94 7:08 AM
Status: Certified
Subject: Reply to: SEED AND CONE COMMITTEE

Reply text:
From: Jesus A. Cota:WO
Date: Jun 21,94 10:08 AM
As I mentioned to you before, the effort to provide guidance to the steering committees has been posponed by Mel. He wants to review Technology Development and the interactive role of the various groups such as the steering committees, MAG, The Center, Davis and others. The previous direction given to the steering committees was to develop tactical plans so that yearly activities could be recommended for the TD Program. I think that this direction has not changed yet. The committees must have good strategic plans in order for them to develop tactical plans used to make recommendations. Improving your strategic plan would lead to an improved tactical plan and thus better recommendations. Nancy or Mel please provide direction if I misunderstand our current position on the issue. ////Jesus

Preceding message:
: Jack Barry:R05H
D: Jun 14,94 1:03 PM
I HAVE BEEN RECEIVING COMMENTS FROM SOME MEMBERS OF THE SEED AND CONE STEERING COMMITTEE THAT THE TACTICAL PLAN THEY DEVELOPED ISN'T STARTEGIC ENOUGH IN ITS PERSPECTIVE. IT IS MY UNDERSTANDING THAT THE WO WANTS A FEW PRIORITY ITEMS IDENTIFIED EACH YEAR AND THAT WO WANTS THESE TIED TO SOME PLAN THAT DEMONSTRATES WE HAVE A RATIONALE FOR THE ANNUAL PRIORITY RECOMMENDATIONS - THUS THE TACTICAL PLAN. I ASSUME WO DOES NOT NEED A STARTEGIC PLAN. I DON'T WANT TO SIT BEFORE THE COMMITTEE AND MISREPRESENT WO'S NEEDS AND WISHES. PLEASE PROVIDE GUIDANCE WHICH I WILL SHARE WITH THE COMMITTEE. THANKS -JACK

-------========X========-------

MESSAGE DISPLAY FOR JACK BARRY

To J.Dewey:r01a
L.Barber:s29a
N.Rappaport:s27a
CC R.Sandquist:r06c
CC J.Barry

From: Jack Barry
Postmark: Jul 26,94 11:49 AM Delivered: Jul 26,94 11:49 AM
Status: Certified
Subject: Seed and Cone Tactical Plan

Message:
At the Rhinelander meeting I asked you to update the information that appears above your name under the various projects in the 5-year plan. I hope to keep the plan updated until the strategic/tactical planning committee produces its plan. I would apprecite your updates that includes brief statements on what has been accomplished under actions, additions/deletions in actions, etc.The committee also suggested that we focus nationally via regionally. This should not entail a lot of effort. Also in most cases the action dates would be advanced one year. You might want to fax changes to me at 916 757-8383. Thanks in advance for your cooperation. Jack

-------========X========-------

Appendix H

R-5 Memorandum - Policy on the Use of Native Plant Material in Restoration

United States Department of Agriculture
Forest Service
Pacific Southwest Region
Regional Office, R5
630 Sansome Street
San Francisco, CA 94111-2214
415-705-1098 Text (TTY)

Reply To: 1330/2070

Date: June 30, 1994

Subject: Policy on the Use of Native Plant Material in Restoration other Revegetation Projects

To: Forest Supervisors, Staff Directors and Station Director, PSW

Maintaining the rich native flora and associated vegetative communities of the Pacific Southwest Region is a critical element of Ecosystem Management. The use of native plants for revegetation and restoration is integral to the overall national goal of conserving the biodiversity, health, productivity, and sustainable use of forest, rangeland, and aquatic ecosystems. Maintaining biodiversity includes retaining the inherent genetic variability within plant populations. Therefore, conservation of local germplasm is a desired outcome of our activities.

We will begin to broaden the base of local native plant materials through careful collection, storage, and production efforts to meet current need and to anticipate the future demand for revegetation. We must move as rapidly as possible toward the use of local native plant material and away from the use of exotics and non-local sources. Forests will follow the set of operational guides (enclosed) to avoid irreversible impacts on native ecosystems. This policy includes the restoration of historic ranges.

The following policy supports ecosystem management efforts. A key element of sustainability is the conservation of natural biological diversity. Native plants are intrinsically valuable, biologically diverse, and ecologically adapted to their habitats. They are key factors in sustaining resilient, healthy, and productive ecosystems.

Effective immediately, R5 policy on the use of native vegetative materials on National Forests will be:

> To the extent practicable, seeds and plants used in erosion control, fire rehabilitation, riparian restoration, forage enhancement, and other vegetation projects shall originate from genetically local sources of native plants.
>
> 1. Prescriptions for use of plant materials for revegetation must be developed by knowledgable plant resource specialists prior to implementation to ensure that the project is feasible and suitable plant material is used.

2. All revegetation facets must be evaluated early in the planning process for Forest projects.

3. Plant materials (seed, cutting, and whole plants) used in all revegetation projects shall originate from genetically local sources of native species, to the extent practicable.

4. Do not use plant materials of species sold as natives if the genetic origin is not known.

5. Plant materials collected or purchased for Forest projects must be carefully evaluated to ensure that these materials are healthy, free of pests, and that they are properly handled, stored, and conditioned for successful use.

The enclosed document is further guidance for implementing this policy. Much of the enclosed material will become part of the Forest Service manual as an R5 supplement. Questions regarding this policy should be referred to David Diaz at D.Diaz:R05a (415-705-1891) or Jay Kitzmiller, Genetic Resource Center Chico at J.Kitzmiller:R05f08d52a (916-895-1176).

/s/ Joyce T. Muraoka, for
RONALD E. STEWART
Regional Forester

Enclosure

Use of Native Vegetative Materials on National Forests

Maintaining the rich native flora and associated vegetative communities of the Pacific Southwest Region is a critical element of ecosystem management. The use of native plants for revegetation and restoration is integral to the overall national goal of conserving the biodiversity, health, productivity, and sustainable use of forest, rangeland and aquatic ecosystems. Maintaining biodiversity includes retaining the inherent genetic variability within plant populations. Therefore, conservation of local germplasm is a desired outcome of our activities. These guidelines provide direction for planning and implementing revegetation projects including rehabilitation and restoration of forest, range, and aquatic ecosystems.

1 - Authority.

1. The National Forest Management Act of 1976 (Sec. 6, 90 Stat. 2949) is the principal legislative mandate that directs the conservation of biological diversity and thus recognizes the value of adapted plant and animal communities.

2. Further direction is provided in Title 36, Code of Federal Regulations, Part 219, Section 27, Subsection G which states: "Management prescriptions, where appropriate and to the extent practicable, shall preserve and enhance the diversity of plant and animal communities, including endemics and desirable naturalized plant and animal species, so that it is at least as great as that which would be expected in a natural forest and the diversity of tree species similar to that existing in the planning area. Reductions in diversity of plant and animal species from that which would be expected in a natural forest, or from that similar to the existing diversity in the planning area, may be prescribed only where needed to meet overall multiple-use objectives. Planned site conversion shall be justified by an analysis showing biological, economic, social, and environmental design consequences, and the relation of such conversions to the process of natural change."

2 - Goals.

1. To conserve the native biological diversity and adaptive capacity of plant communities, species, and populations. This includes maintaining the integrity of the natural pattern of adaptive genetic structure within and among populations of a species.

2. To reduce the adverse impacts of management activities on the basic natural resources of soil, water, and plant gene pool diversity.

3. To stabilize soil after major disturbances while concurrently avoiding long-term adverse effects on the composition, structure, and function of natural plant communities.

4. To maintain or enhance water quality by controlling the composition and structure of plant communities through use of appropriate plant materials.

5. To prevent the displacement of native species through the introduction of aggressive, long lasting, undesirable vegetation into managed or natural plant communities.

6. To move rapidly toward the general use of locally adapted native plant species in ecosystem management.

7. To guide the program development for acquiring, propagating, and using native plant materials for interdisciplinary ecosystem management projects. These include wildlife, riparian, watershed, road-side, emergency post-fire soil stabilization, and other revegetation and restoration projects.

8. To stimulate development of new ways to achieve ecosystem management objectives that consider multidisciplinary long-term effects. This includes the evaluation of alternatives that provide economical as well as practical means to restore plant communities.

3 - Policy.

To the extent practicable, seeds and plants used in erosion control, fire rehabilitation, riparian restoration, forage enhancement, and other vegetation projects shall originate from genetically local sources of native plants. Native plants are intrinsically valuable, biologically diverse, and ecologically adapted to their habitats. They are key factors in sustaining resilient, healthy, and productive ecosystems. This policy supports management for sustainable use of ecosystems. A key element of sustainability is the conservation of natural biological diversity.

1. Prescriptions for use of plant materials must be developed for revegetation by knowledgable plant resource specialists prior to implementation to ensure that the project is feasible and that suitable plant material is used.

2. All revegetation facets must be evaluated EARLY in the planning process for Forest projects. For projects that involve soil disturbance, special consideration must be given to stockpiling of duff or topsoil (with seedbank and mycorrhizae) for later use in restoration of soil and vegetation, and where erosion control is required, mechanical methods must also be evaluated. All revegetation projects must consider both natural and artificial regeneration alternatives including collection of local sources of suitable native plant seed or cuttings, nursery propagation, and on-site planting and maintenance activities.

3. Plant materials (seed, cuttings, and whole plants) used in all revegetation projects shall originate from genetically local sources of native species, to the extent practicable.

   a. Encourage natural regeneration where seed source and soil conditions are favorable. Where natural regeneration is likely to fail within the desired time frame and soil protection is necessary, evaluate the use of non-vegetative techniques that allow natives to return, such as weed- and disease-free mulching, erosion blankets, or sterile straw waddles.

   b. Alternatively, collect seed as near to the site as possible within an adaptive (seed) zone, follow genetic guidelines, and grow in the appropriate nursery. If a genetically local or similarly adapted stock of native species is not available for revegetation, consider either

eliminating, delaying, or modifying the project such as planting natives in stages as they become available.

c. When project objectives justify the use of non-native plant materials, documentation explaining why non-natives are preferred will be part of the project planning process.

4. Do not use plant materials of species sold as natives if the genetic origin and physiological quality is not known. For now use only those commercial sources of native plant materials collected within the same ecological section (National Hierarchy of Ecological Units) or geographic subdivisions at the district level as mapped in the Jepson Manual (1993) as your project area. Refer to the genetic guidelines and the use the seed zoning rules for further guidance. Avoid the use of plant material bred and/or grown outside of California.

5. Plant materials collected or purchased for Forest projects must be carefully evaluated to ensure that these materials are healthy, free of pests, and that they are properly handled, stored, and conditioned for successful use.

4 - Explanation.

1. Intent. Policies and procedures for reforestation of conifer trees are well documented and are based on decades of research and practice. In addition, seeds are now readily available for most local sources of native conifers due to on-going seed collection and storage practices. However, for other native plant species such documentation and seed availability do not generally exist. This new policy is aimed at moving rapidly toward the general use of locally adapted native plant species in ecosystem management and for revegetation of any project area that has reasonable reestablishment potential. Through natural selection, native species have become well-adapted to their native environments, including both the biotic and abiotic elements.

2. Use of Exotics. Non-native species or populations of natives that are adapted to a different locale may sometimes be extremely useful, especially in the short-term for revegetating to stabilize severely disturbed sites. Common examples include wildfires, road-building, and mining activities. However, selection of the proper species and genetic source for use in these situations should be carefully decided, because many commercially available stocks are persistent, invasive, and also may have great potential for disrupting natural communities and processes for a long time. For example, certain non-native grass species have been selectively bred for rapid establishment which makes them aggressive competitors and causes displacement of native woody plant species.

The introduction of plant species or seed sources that are not adapted to the planting site or are not compatible with the native species may adversely affect ecosystem integrity. Exotics or non-locally adapted populations may be poorly adapted to certain locales, resulting in low survival, slow growth, and high susceptibility to environmental extremes and to endemic pests. Furthermore, new insects or diseases may be unknowingly introduced into our forest ecosystems by use of non-native species or by use of native stock grown in foreign nurseries. Such events could permanently alter ecosystems beyond the range of natural variability.

3. Constraints to Use of Natives. In certain cases, reliance on non-native species can be reduced only gradually over time. Major barriers to the use of natives may exist. Cost factors, availability of plant materials, and capability of propagating a wide variety of native plants will have to be developed through experience and research. Current budgeting constraints present a challenge because project planning, seed collection, and nursery propagation span multiple years, yet funding linked to targets involves a single year perspective. In the short term, these limitations could lead to a decision to use alternative methods for a project. After other alternatives have been thoroughly evaluated, if use of exotics is deemed necessary, favor exotics with low reproductive fitness, short longevity, or self-pollination to reduce gene pollution and undesirable long-term effects on the ecosystem.

5 - Definitions.

1. Revegetation - a general term for renewing the vegetation on a project site, which may include restoration and rehabilitation.

2. Rehabilitation - improving a project site to a more desired condition than previously existed usually as a result of a major disturbance.

3. Restoration - reestablishing a project site to a previously existing natural condition using similar or identical native vegetation.

4. Native plant - one that occurs and has evolved naturally in the Region as determined by climate, soil, and biotic factors.

5. Genetically local source - plant materials that originated at or within the same seed zone and elevation band as the project site.

6. Exotic or non-native species - one that was introduced through human activity.

7. Undesirable plant - may be non-native species, non-adapted source, genetically changed through selection in a foreign dissimilar environment, or possesses trait(s) that conflict with accomplishment of objectives.

Genetic Guidelines for Plant Collections

1) Origin is known

   a) Document location of parent plants (see FSH 2409.42)
   b) Identify and track collections from origin to nursery and back to field using a database management system.
   c) Monitor survival, health, and growth performance over time.

2) Locally adapted

   a) Seed origin should be as close as possible to the project site.
   b) Use California tree seed zones to guide the transfer of plant materials.

      1. See California tree seed zone map and rules established in 1970 (Buck, et. al.). These provide a framework for determining gene transfer priorities based on geoclimatic factors, when other information is lacking.
      2. Collect and use plant materials within local 500 ft elevation bands where possible and never transfer woody plants more than 1000 ft up or down in elevation in the same seed zone.
      3. Avoid transferring plant materials from one geographic district to another. Geographic districts are those described in the Jepson Manual.

   c) Where possible, within seed zones and elevation bands collect and use plant materials within the same vegetation series, or for riparian species, within watershed delineations.
   d) Collect and use plant materials in more localized area in certain situations where site-specific ecotypes may develop, including:

      1. populations on unusual soils (e.g. serpentine)
      2. populations from extreme or marginal environments for the species (tolerance limits to temperature, precipitation, nutrients, etc).
      3. populations with known or suspected unique genetic characteristics.

3) Genetically diverse

   a) Plant materials should be collected from the project site. If not possible, plant materials should be collected from several sub-populations that are well-distributed within an adaptive (seed) zone.
   b) Separate collections by 100 ft or greater for most outcrossing woody plants to ensure unrelatedness. Note: closer spacing may be appropriate for certain forbs and grasses that are highly specialized to their microenvironments.
   c) Collect an approximately equal number of seeds/cuttings from each parent representative of that population. Ensure that the collection comes from a large number (30-50 but number depends on exact species) unrelated parents.

4) High quality

a) Select healthy, vigorous parent stock.
b) Collect at appropriate time (e.g. when seeds are mature and cuttings are dormant).
c) Use optimal collection, processing, and storage procedures.
d) Use cultural practices that will maximize the success rate (minimize losses) from collection to nursery and on through project completion.

Quality Control Guidelines

1) Acquisition of plant material

   a) Nursery and other appropriate resource personnel provide advice on quality standards for the acquisition of plant materials (force account, contract, or purchase) that will ensure that the plant materials are in a suitable physiological condition when delivered for whatever cultural activity (sowing, growing, storing, outplanting, etc) is required.

2) Plans for using plant material

   a) Prior to receipt of plant material, handling procedures must be "in place" to ensure proper storage conditions for seeds, cuttings, or plants and to ensure proper care and tending during seeding, grafting, or planting operations.

Project Coordination Guidelines

1) Project Implementation

   a) All projects should be carefully reviewed prior to implementation by appropriate biological professionals for advice on how to obtain suitable genetic sources and how to care for local, native plant materials (geneticists, nursery managers), on help to prepare and administer contracts for planting (district reforestation personnel), and to ensure the suitability of species and resource objectives (botanists, ecologists, silviculturists, etc.).

   b) The review process should evaluate whether objectives are sound and that they can feasibly be met.

2) Monitoring process

   a) Project monitoring should include assessing the effectiveness of the use of native plants for restoration and/or rehabilitation.